

CD120 Series Servo

User Manual

2013/1/15

Content

Chapter 1 Product Acceptance & Model Description	4
1.1 Product Acceptance	4
1.2 Model Descriptions	4
1.2.1 Nameplate Descriptions	4
1.2.2 Model Description	5
1.3 Servo Drivers and Motors Selection Table	6
1.4 Components Descriptions of Servo Driver	7
Chapter 2 Precautions and Installation Requirements	8
2.1 Precautions	8
2.2 Environmental Conditions	8
2.3 Mounting Direction & Spacing	8
Chapter 3 Interfaces and Wirings of CD120 Driver	10
3.1 Wiring Diagram	10
3.2 Interface of Driver	11
3.2.1 X1 RS232 and Encoder Output	11
3.2.2 X2 Encoder Input	11
3.2.3 X3 IO Interface	12
3.2.4 X4 Main Power Interface	12
Chapter 4 Motor Selection and Trial Operation	13
4.1 Motor Selection	13
4.2 Online	15
4.3 Trial Operation	17
Chapter 5 Operation Mode	22
5.1 IO Function	22
5.2 Operation Mode	25
5.2.1 Pulse Mode (Mode -4)	25
5.2.2 Speed Mode (Mode 3 and -3)	31
5.2.3 Internal Multi-position mode (Mode 1)	41
5.2.5 Homing Mode (Mode 6)	49
Chapter 6 Control Performance	51
6.1 Auto Reverse	51
6.2 Driver Performance Tuning	52
6.2.1 Manual Adjustment	52
6.2.2 Auto Adjustment (Only for Velocity Loops)	56
6.3 Oscillation Inhibition	58

6.4 Debugging Example.....	59
6.4.1 Oscilloscope.....	59
6.4.2 Procedure for Parameter Adjustment	61
Chapter 7 Troubleshooting	67
7.1 Alarm Messages.....	67
7.2 Troubleshooting	67
Chapter 8 Appendix	69
8.1 Homing Mode.....	69
8.2 Servo Drivers and Motors Selection Table	74
8.3 Technical Specifications of Servo Driver	75
8.4 Technical Specifications of Servo Motor.....	76
8.4.1 SME Series.....	76
8.4.2 F Series.....	77
8.5 Dimensions of Servo Driver (Unit: mm)	78
8.6 Brake Resistor Selection Table	79

Chapter 1 Product Acceptance & Model Description

1.1 Product Acceptance

Item for Acceptance	Remark
Whether the model of a delivered CD series servo system is consistent with the specified model	Check the nameplate of a servo motor and that of a servo driver
Whether the motor shaft rotates smoothly	Rotate the motor shaft by hand,if it can rotate smoothly,means normal.For the motor with brake,it can't rotate by hand.
Whether any breakage occurs	Check the external appearance completely for any losses that are caused by transportation
Whether any screws are loose	Check for loose screws with a screwdriver

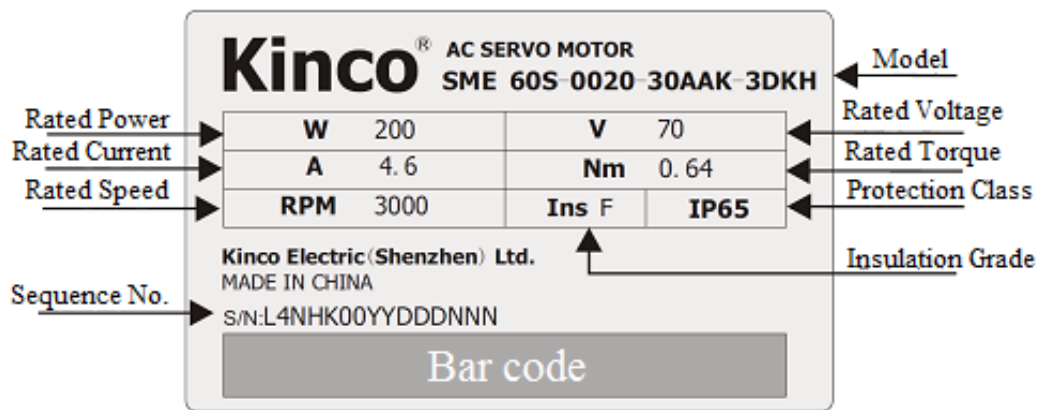
1.2 Model Descriptions

1.2.1 Nameplate Descriptions

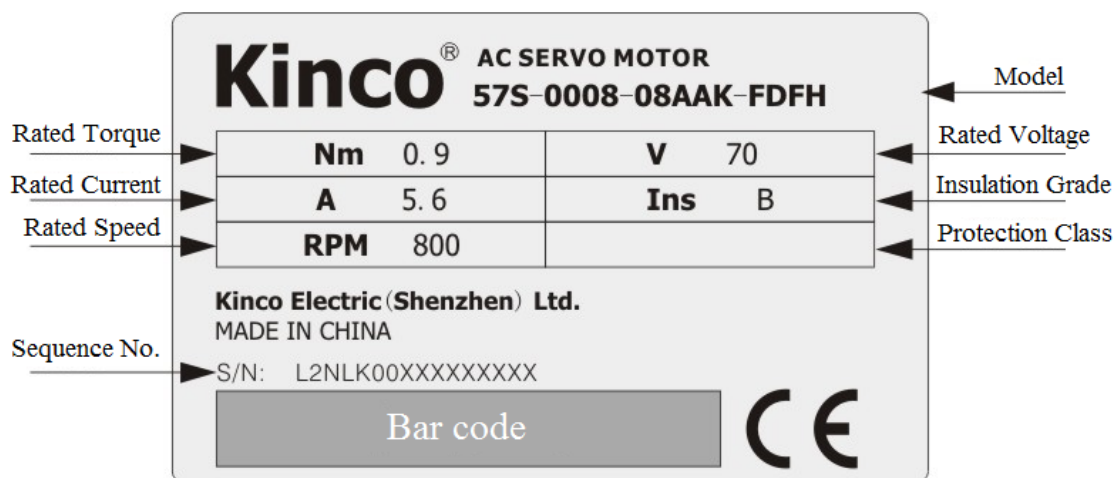
1.Nameplate of Servo Driver



2.Nameplate of SME Series Motor

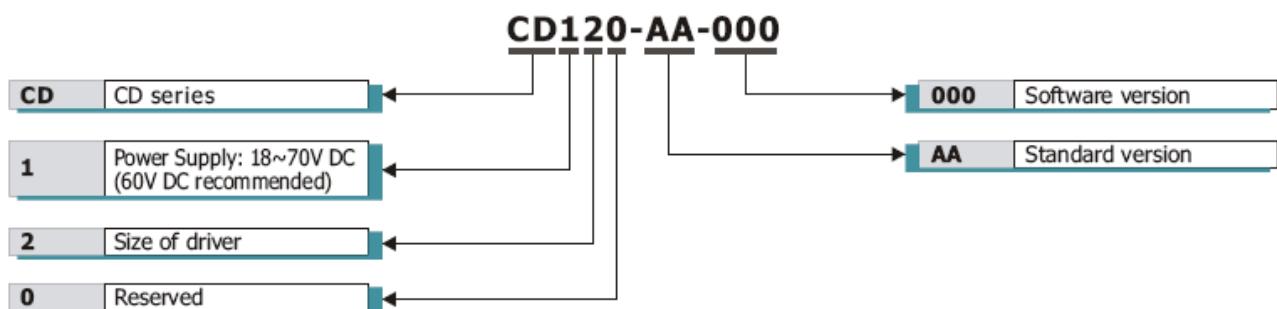


3.Nameplate of F Series Motor

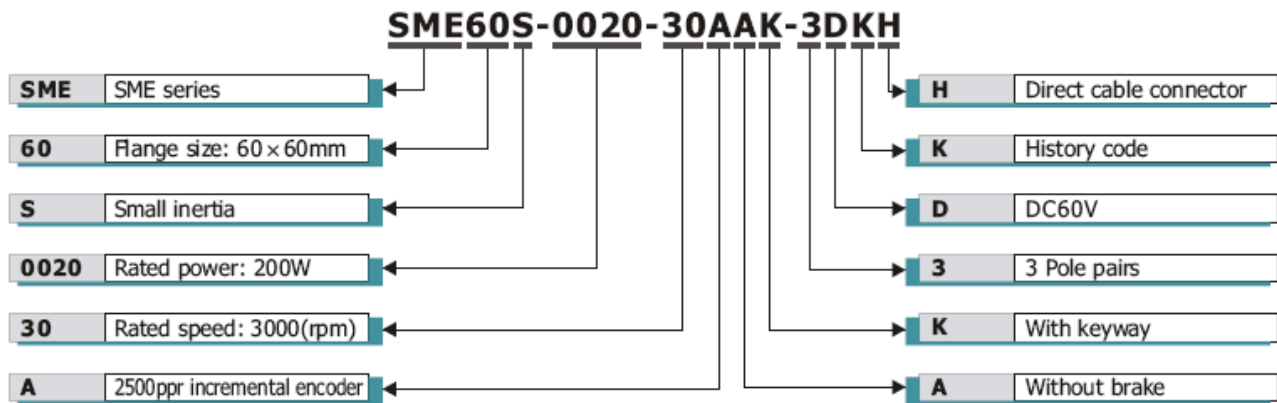


1.2.2 Model Description

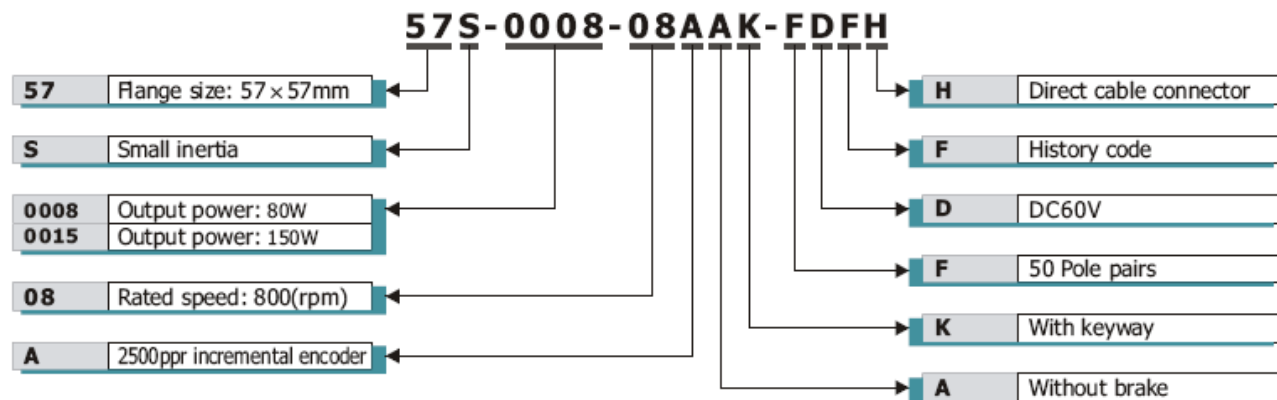
1.CD120 Series Driver



2.SME Series Motor



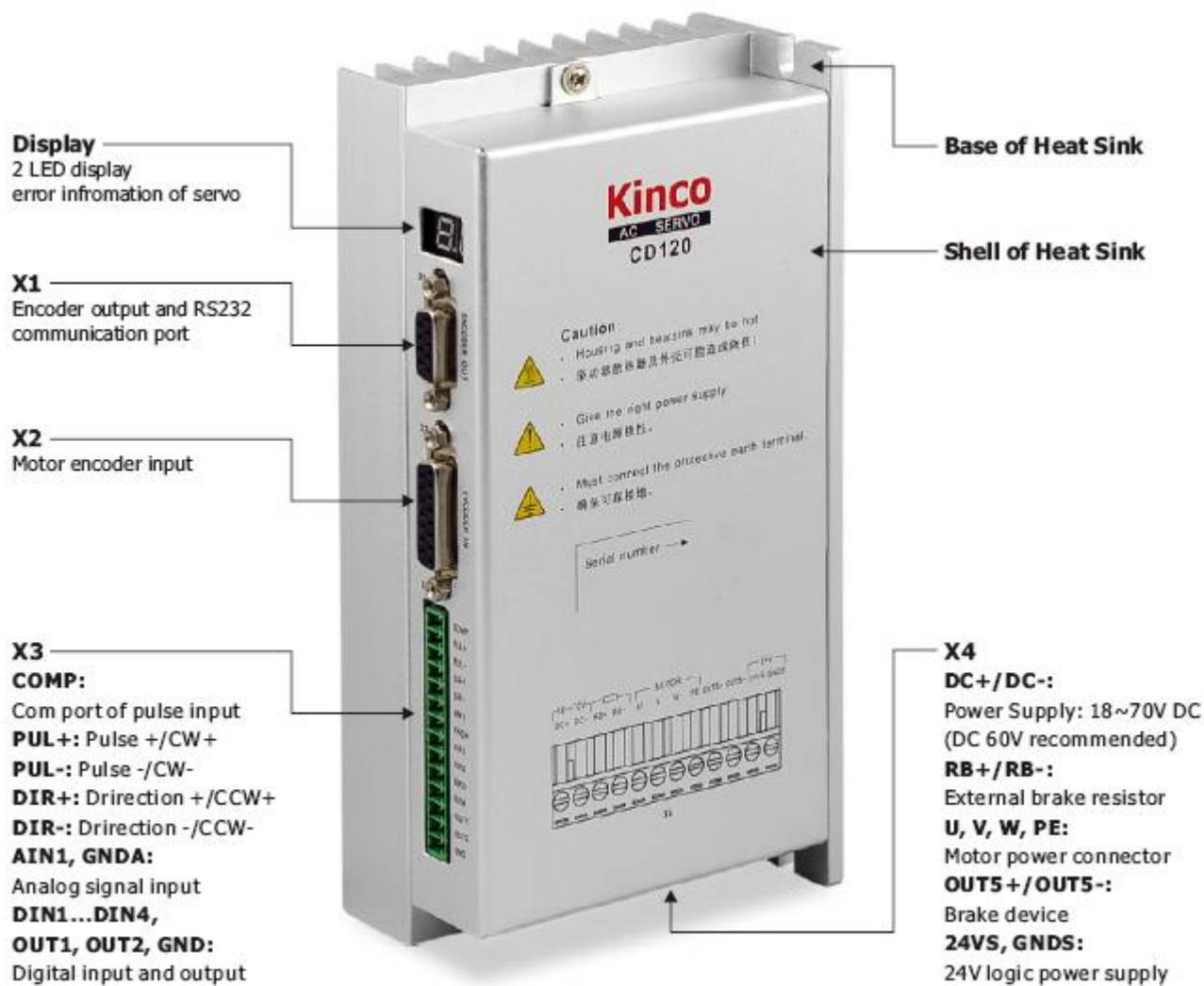
3.F Series Motor



1.3 Servo Drivers and Motors Selection Table

Series	Servo Driver	Servo Motor	Description	Power Cable	Encoder Cable	Rated speed/ Rated torque/ Rated current
Small inertia DC60V	CD120-AA-000	57S-0008-08AAK-FDFH	Standard direct cable motor	MOT-005-LL-KL-D	ENCCF-LL-FH	800rpm/ 1Nm/ 5.6A
		57S-0015-08AAK-FDFH				800rpm/ 1.5Nm/ 5.8A
		SME60S-0020-30AAK-3DKH				3000rpm/ 0.64Nm/ 4.8A

1.4 Components Descriptions of Servo Driver



Chapter 2 Precautions and Installation Requirements

2.1 Precautions

1. Tightly fasten the screws that fix the motor;
2. Make sure to tightly fasten all fixed points when fixing the driver;
3. Do not tighten the cables between the driver and the motor/encoder;
4. Use a coupling shaft or expansion sleeve to ensure that both the motor shaft and equipment shaft are properly centered;
5. Do not mix conductive materials (such as screws and metal filings) or combustible materials (such as oil) into the servo driver;
6. Avoid the servo driver and servo motor from dropping or striking because they are precision equipment;
7. For safety, do not use any damaged servo driver or any driver with damaged parts.

2.2 Environmental Conditions

The product must be placed in the box before installing, If the drive is not in use,.In order to make the products to conform to the warranty and maintenance,please pay attention to following precautions when storing it.

1. Must be placed in grime, dry location.
2. The ambient temperature of the storage location must be in the range of $-20^{\circ}\text{C} \sim +40^{\circ}\text{C}$ ($-4^{\circ}\text{F} \sim 129^{\circ}\text{F}$).
3. The relative humidity of the storage location must be in the range of 0% to 90% and non-condensing.
4. Do not store in location with corrosive gases and liquids.
5. Correctly packaged and placed on a shelf or countertop.

Note: To ensure the reliability of the product ,prolonged operation is proposed below the ambient temperature at 45°C .

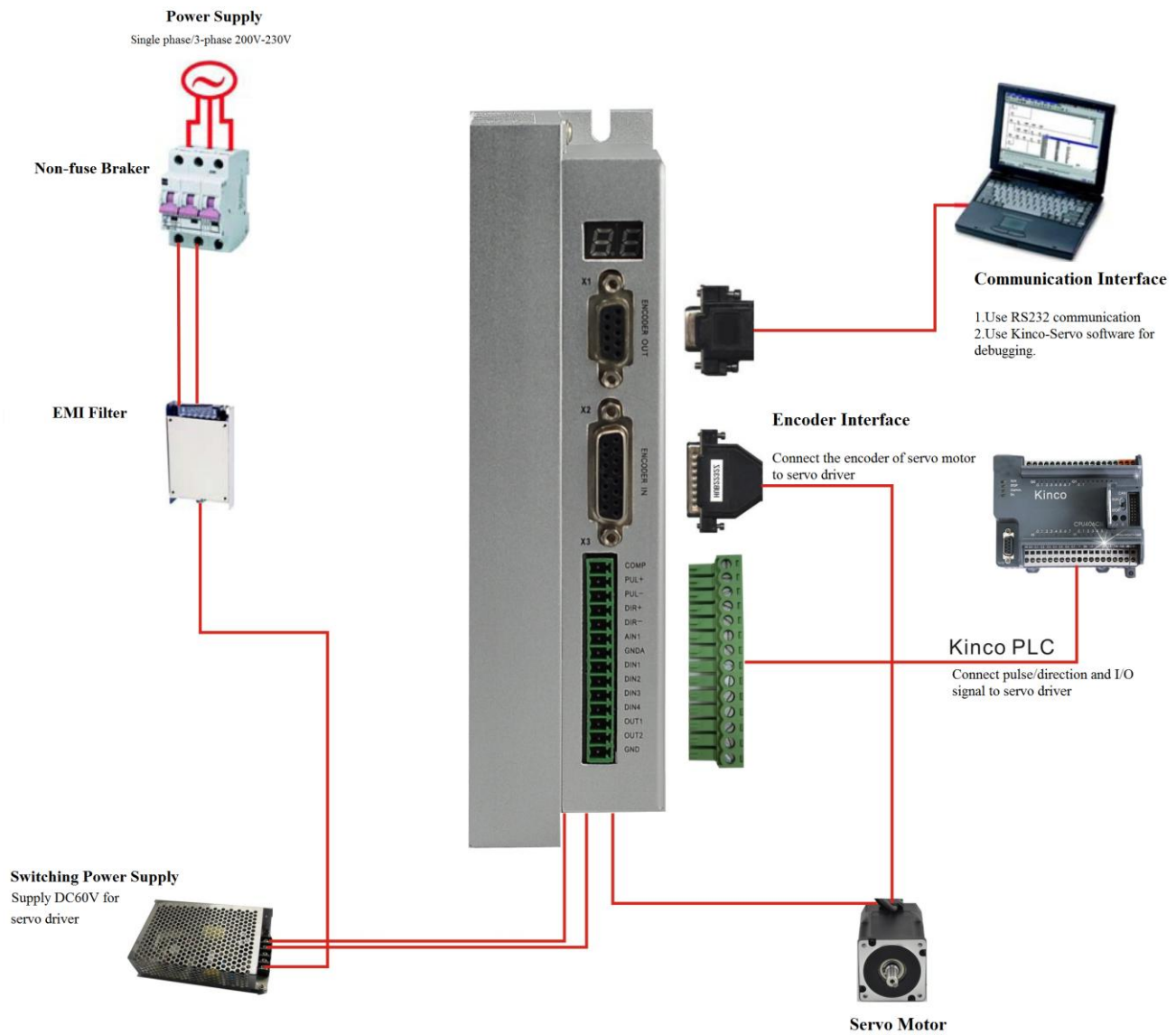
2.3 Mounting Direction & Spacing

Precautions

1. To prevent possible faults, install a servo driver in a proper direction;
2. To prevent possible faults, ensure that the space between a servo driver and the inner wall of the control cabinet as well as that between the servo driver and the neighboring driver are the same as specified space..
3. To prevent possible faults,the suction vent of servo driver can't be sealed when installing,and can't be install in horizontal.

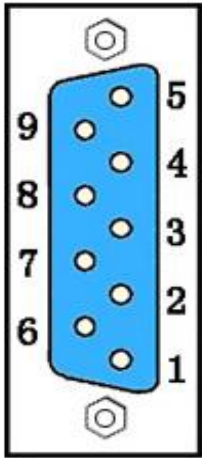
Chapter 3 Interfaces and Wirings of CD120 Driver

3.1 Wiring Diagram



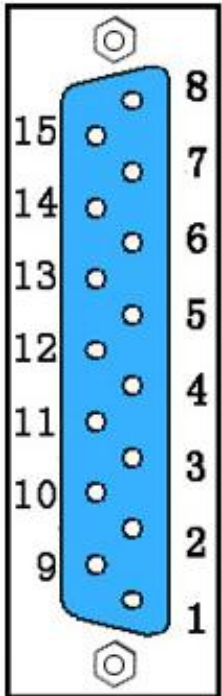
3.2 Interface of Driver

3.2.1 X1 RS232 and Encoder Output



Interface	Pin No.	Signal	Description	Function
X3 (9-pin female connector)	1	RXD	To receive data	RS232 communication interface
	5	TXD	To transmit data	
	6	GND	Ground of signal	
	2	A	To output phase-A signal of encoder	Output interface of encoder in motor
	7	/A		
	3	B	To output phase-B signal of encoder	
	8	/B		
	4	N	To output index signal(Z signal) of encoder	
	9	/N		

3.2.2 X2 Encoder Input



Interface	Pin No.	Signal	Description	Function
X4 (15-pin female connector)	1	+5V	To output 5 V voltage	Input interface of encoder in motor
	9	GND	0 V	
	8	NC	N/A	
	2	A	To input phase-A signals of encoder	
	10	/A		
	3	B	To input phase-B signals of encoder	
	11	/B		
	4	N	To input phase-Z signals of encoder	
	12	/N		
	5	U	To input phase-U signals of encoder	
	13	/U		
	6	V	To input phase-V signals of encoder	
	14	/V		
	7	W	To input phase-W signals of encoder	
	15	/W		

3.2.3 X3 IO Interface

Interface	Terminal	Function
X3	COMP	Common terminal for pulse input
	PUL+	Pulse signal+
	PUL-	Pulse signal-
	DIR+	Direction signal+
	DIR-	Direction signal-
	AIN1	Analog input 1
	GNDA	Common terminal for analog input
	DIN1	Digital input 1
	DIN2	Digital input 2
	DIN3	Digital input 3
	DIN4	Digital input 4
	OUT1	Digital output 1
	OUT2	Digital output 2
	GND	Common terminal for digital signal (0V for logic power)

3.2.4 X4 Main Power Interface

Interface	Terminal	Function
X4	DC+/DC-	Main power interface(DC60V)
	RB+/RB-	Braking resistor interface
	U/V/W/PE	Motor cable interface
	OUT5+/OUT5-	Motor brake interface
	24VS	Logic power 24V
	GNDS	Logic power 0V

Chapter 4 Motor Selection and Trial Operation

4.1 Motor Selection

1. Driver and motor configuration(The motor's model should be Capital letters in software)

PC		Motor Model	CD120
K@	404.b	No motor selected	Blinking FF when servo is not enable
			Display 16 when servo is enable
L2	324.c	57S-0008-08AAK-FDFH	√
L3	334.c	57S-0015-08AAK-FDFH	√
L4	344.c	SME60S-0020-30AAK-3DKH	√
L5	354.c	57S-0010-10AAK-FDFH	√

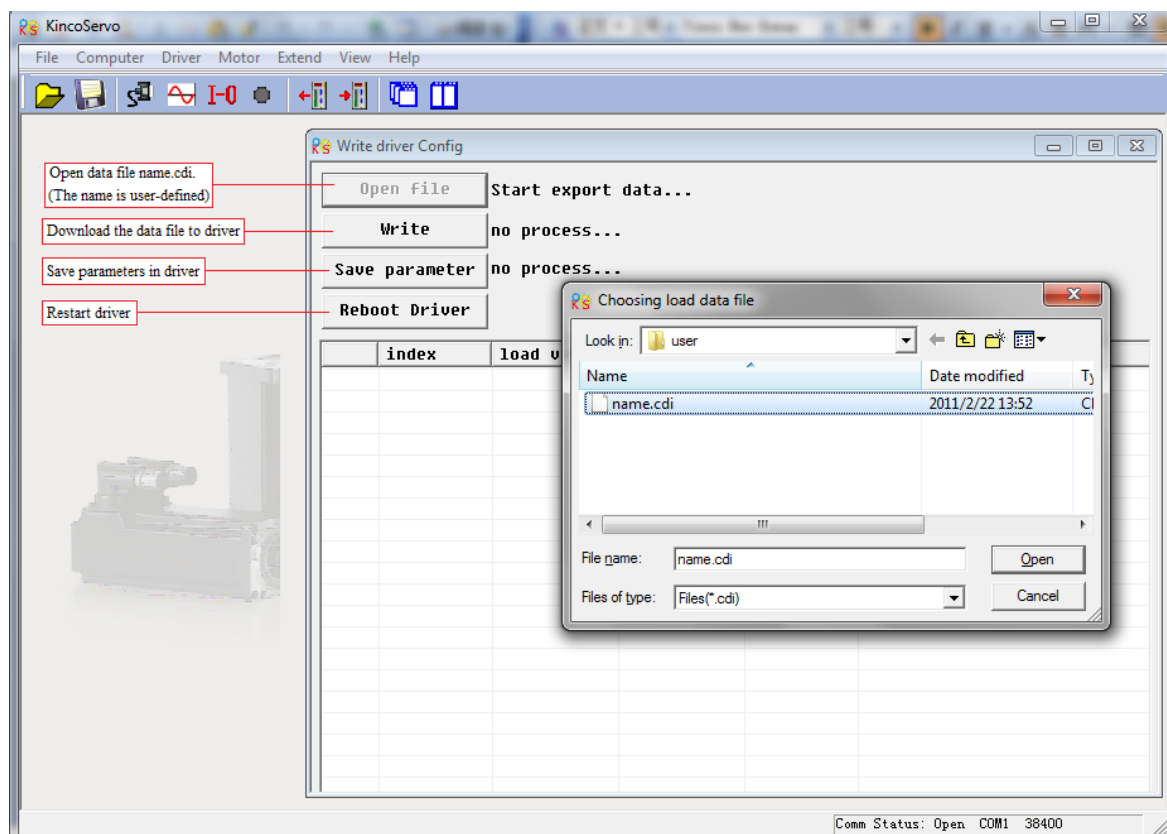
2. Explain in detail

Kinco servo does not configure motor in default setting.

(1)Customers have the data file (**Configure motor by downloading data file**)

Use the CD-PC software to download data file to servo driver, then driver and motor can work normally. Please contact us if there is any problem after downloading. In CD-PC, click the **Extend-->Write Driver Config**. Then open the data file (For example, name.cdi), write it to driver.

Note: You should download the new version software from our website: <http://www.kinco.cn/en/>



(2) Customers do not have data file (**They need configure motor model in servo**)

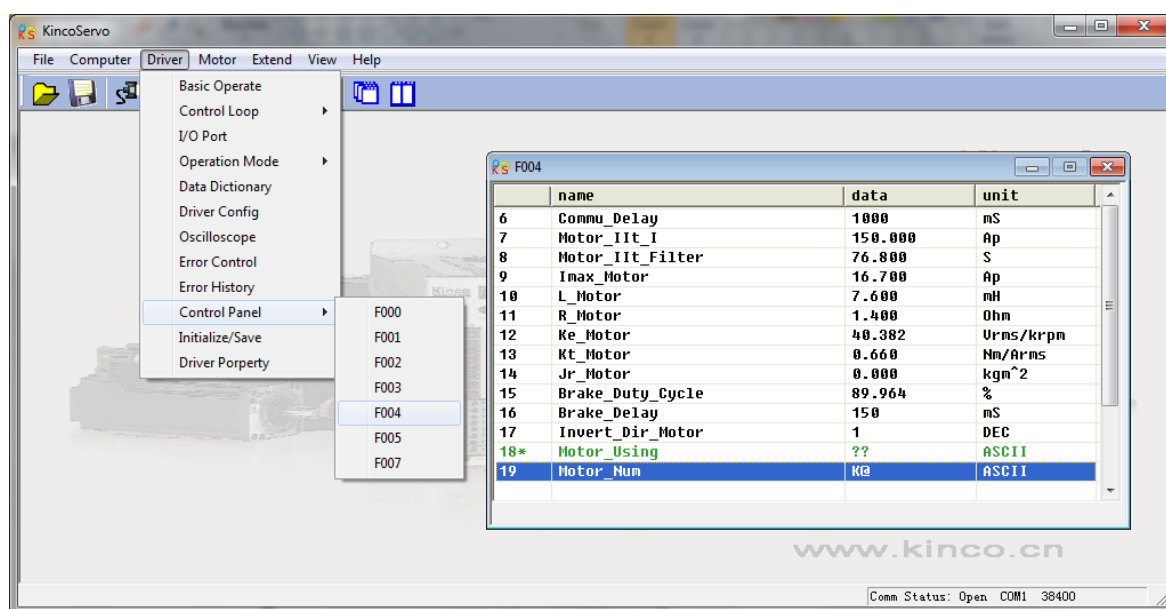
Customers can configure the motor's model according to driver and motor configuration table mentioned above, then set the parameters according to the application. If the motor's model do not configure properly, the driver and motor may not work normally. You can configure motor model via keys on servo or CD-PC software.

Servo	Software Operation	Connection Cable																
CD120-AA-000	√	<table><thead><tr><th colspan="2">PC(DB9 Male)</th><th colspan="2">Servo(DB9 Female)</th></tr></thead><tbody><tr><td>RXD</td><td>2</td><td>5</td><td>TXD</td></tr><tr><td>TXD</td><td>3</td><td>1</td><td>RXD</td></tr><tr><td>GND</td><td>5</td><td>6</td><td>GND</td></tr></tbody></table>	PC(DB9 Male)		Servo(DB9 Female)		RXD	2	5	TXD	TXD	3	1	RXD	GND	5	6	GND
PC(DB9 Male)		Servo(DB9 Female)																
RXD	2	5	TXD															
TXD	3	1	RXD															
GND	5	6	GND															

Configure Motor (CD-PC Software Operation)

Connect the servo to PC, open the CD-PC, then Menu—Driver—Control Panel—F004, in the F004, in the F004, set d4.19: **Motor Num** (Please refer to the servo and motor configuration table), after that press Enter to confirm, then restart servo.

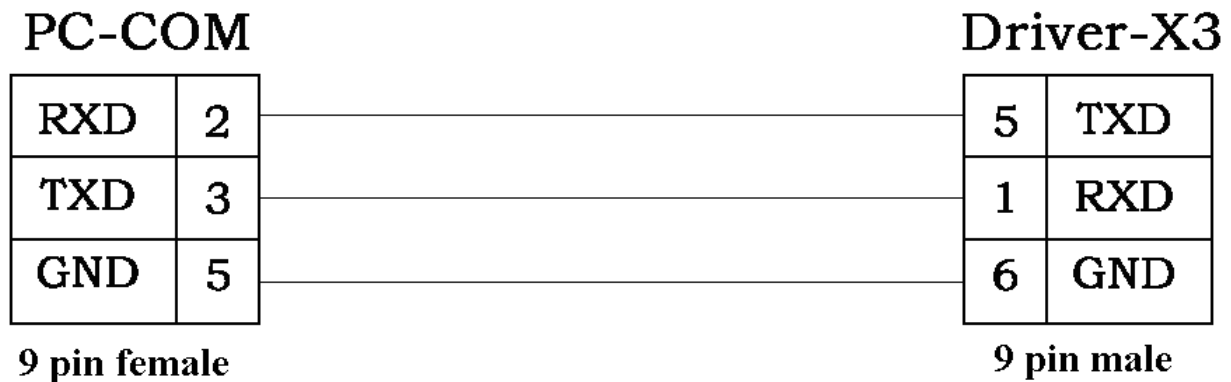
Please configure the right Motor's model before restart. If the customers want to reset the motor model, they should set d4.19 (Motor Num in F004) to 00(Press ENTER to confirm), then enter the **Initialize/Save** page, click the **Save motor parameters**. After restart the servo, they can reset the motor model and set servo parameters.



4.2 Online

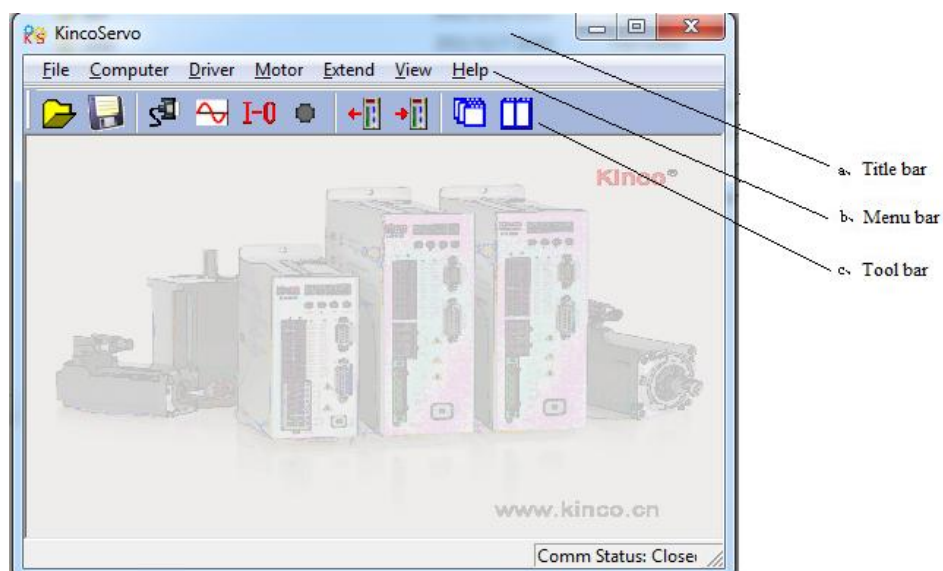
1.Wiring Diagram

The wiring diagram for connecting PC and CD120 driver is as following figure:

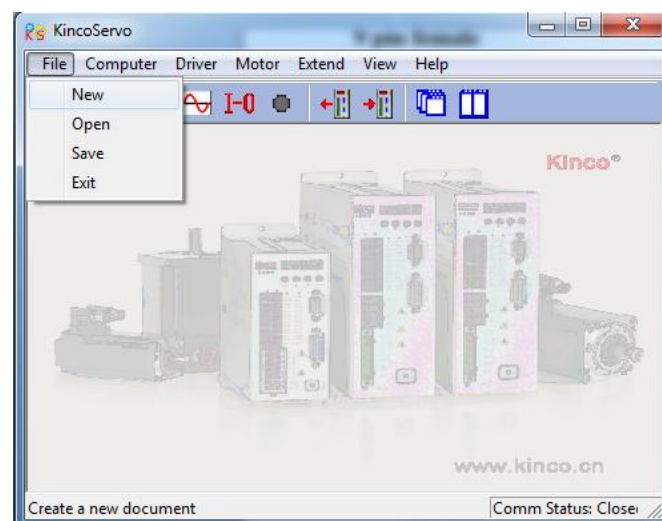


2. Software

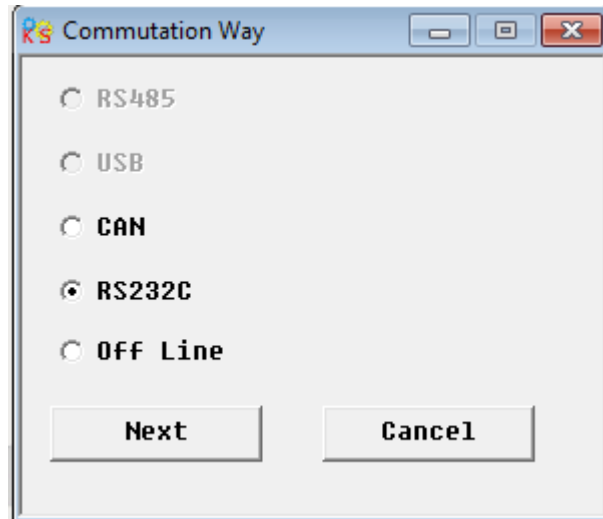
(1)Open CD-PC folder,double click icon  to open the software as shown in following figure:



(2) Create new project



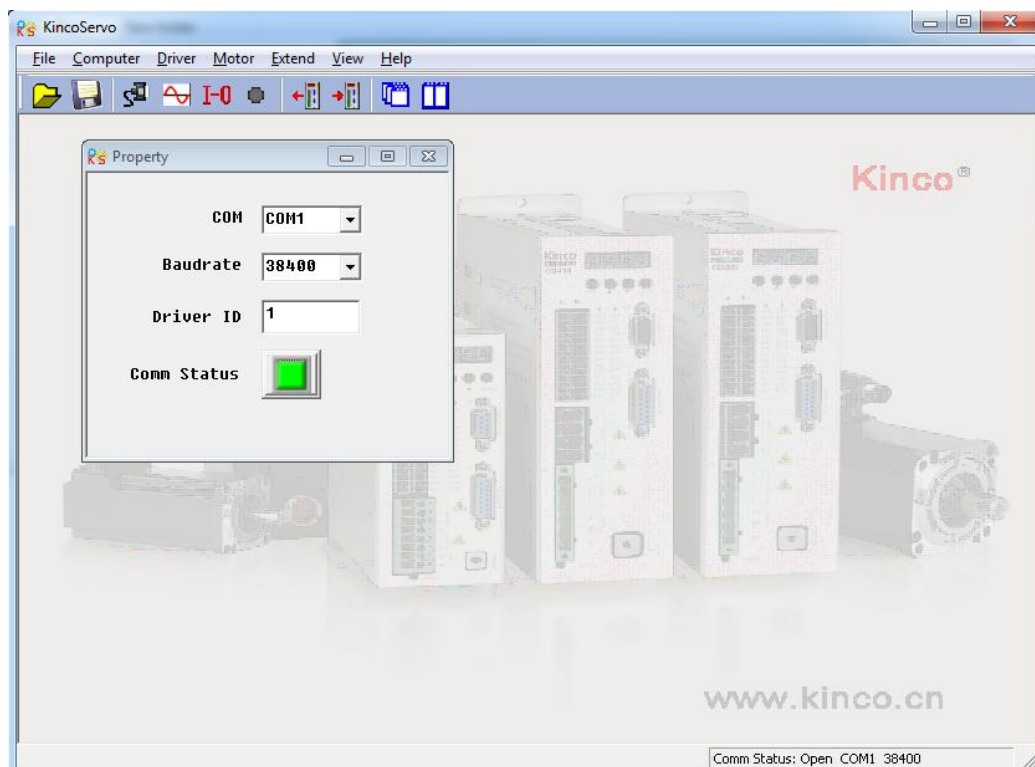
(3)Popup window “Communication Way”,then choose “RS232C” and click Next.



(4)Enter Property window,set the parameters like COM,Baudrate and Driver ID.Then click button 

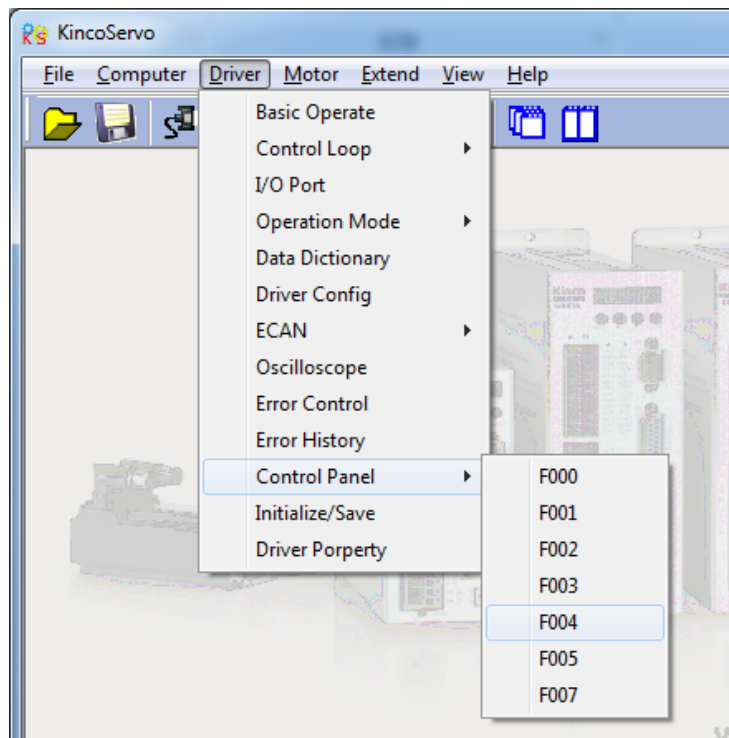


(5)If there is message “Comm Status:Open COM1 38400” in the Down-right corner of the software,it means online successfully.

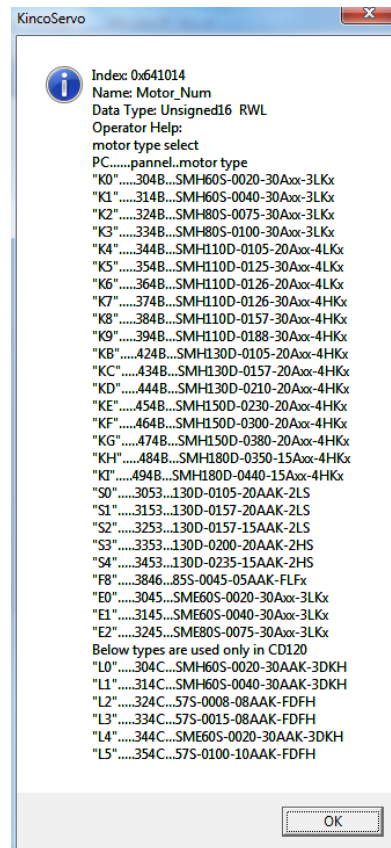
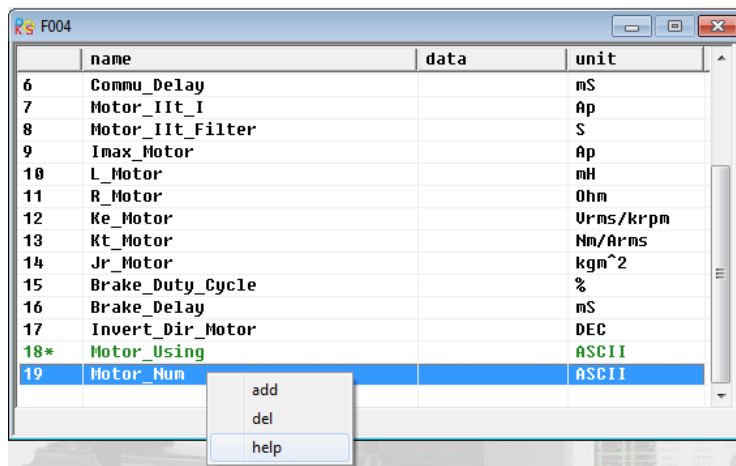


4.3 Trial Operation

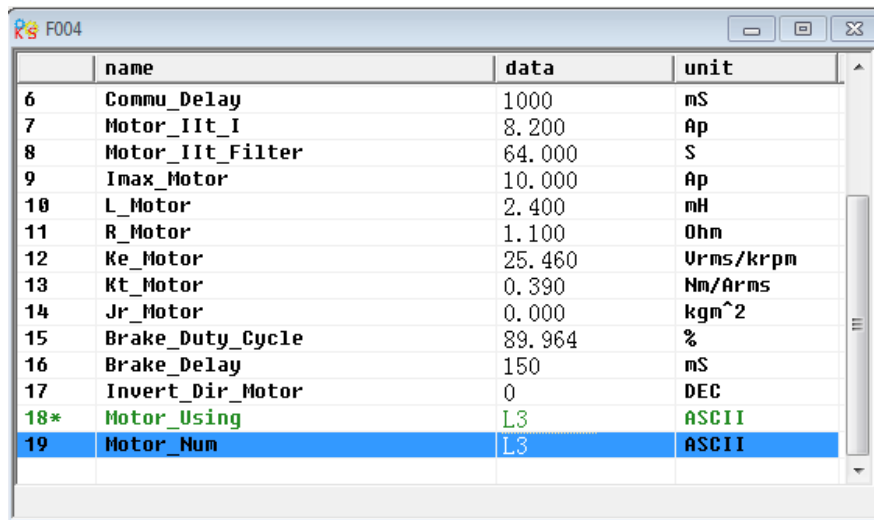
1. Enter Group F004 as shown in following figure.



2. Right click the parameter and select “help” to check the motor model.



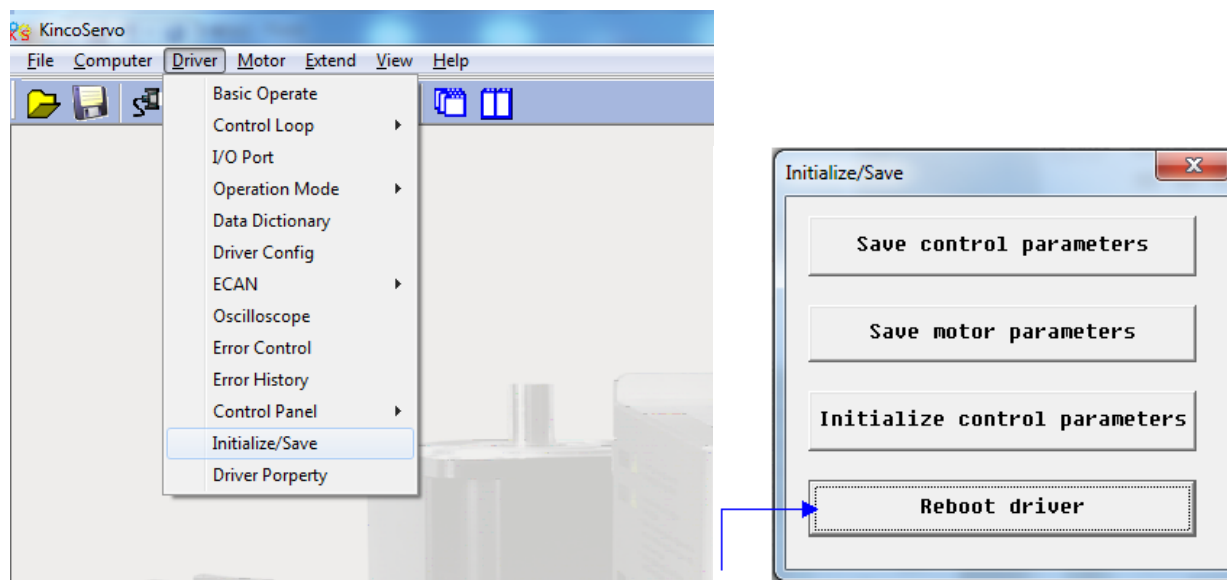
3. When changing the motor model, it should be Capital letters and numbers.




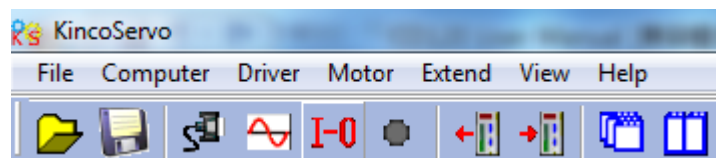
The screenshot shows a window titled 'F004' containing a table of motor parameters. The table has four columns: 'name', 'data', and 'unit'. The rows are numbered 6 through 19. Row 18 is highlighted in green, and row 19 is highlighted in blue.

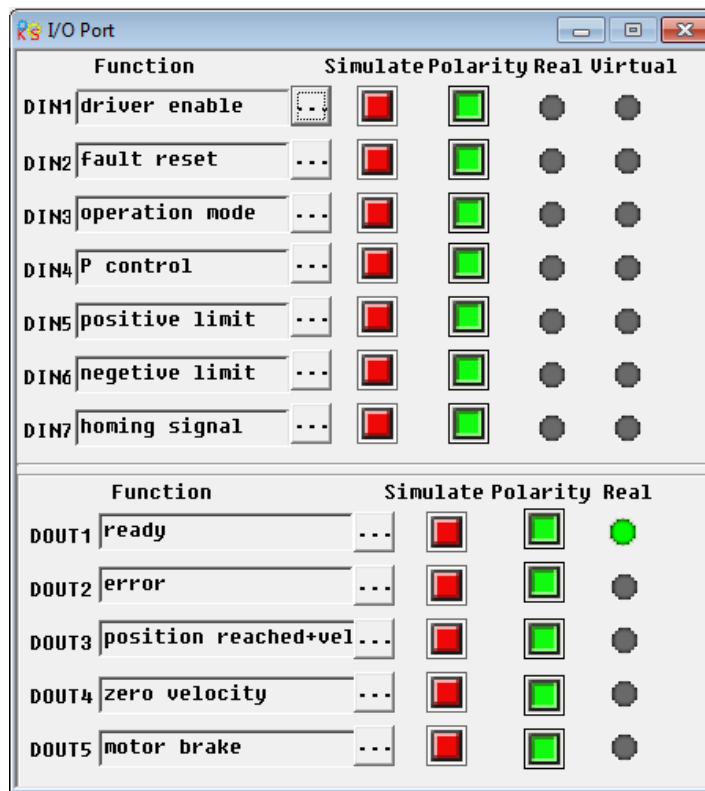
	name	data	unit
6	Commu_Delay	1000	mS
7	Motor_Ilt_I	8.200	Ap
8	Motor_Ilt_Filter	64.000	S
9	Imax_Motor	10.000	Ap
10	L_Motor	2.400	mH
11	R_Motor	1.100	Ohm
12	Ke_Motor	25.460	Vrms/krpm
13	Kt_Motor	0.390	Nm/Arms
14	Jr_Motor	0.000	kgm^2
15	Brake_Duty_Cycle	89.964	%
16	Brake_Delay	150	mS
17	Invert_Dir_Motor	0	DEC
18*	Motor_Using	L3	ASCII
19	Motor_Num	L3	ASCII

4. After changing, it needs to restart driver.

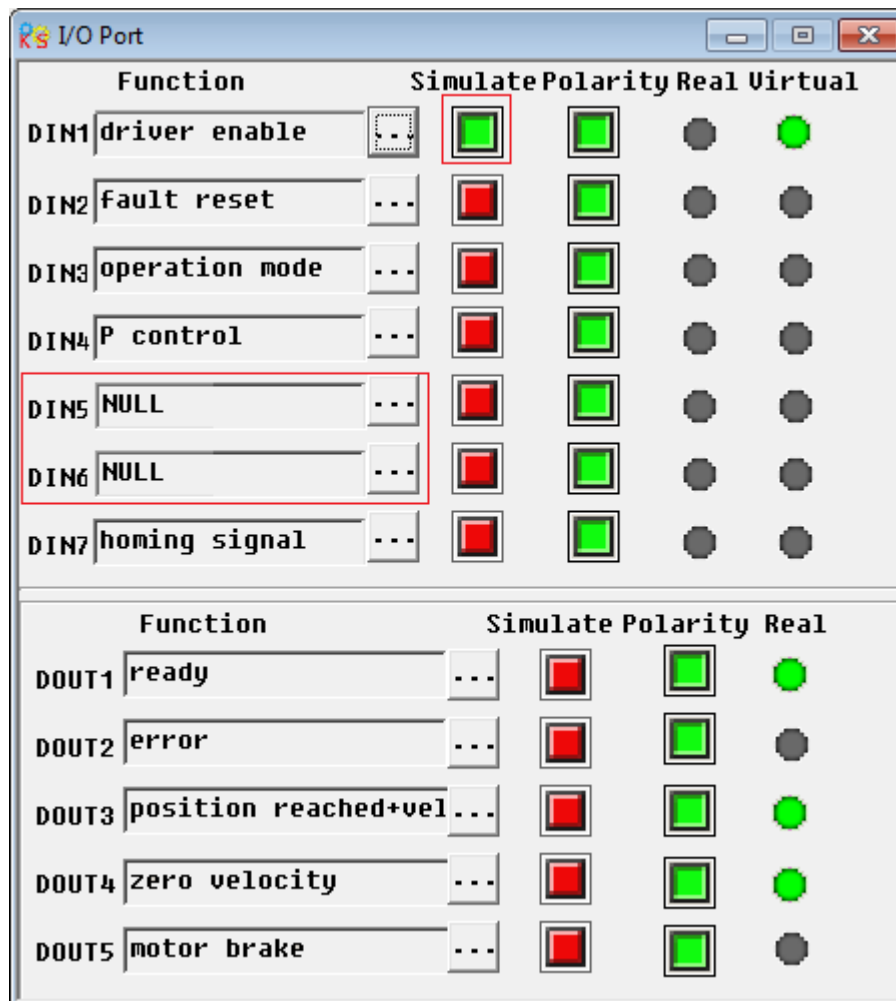


5. Click the icon  in toolbar, then popup I/O control window.

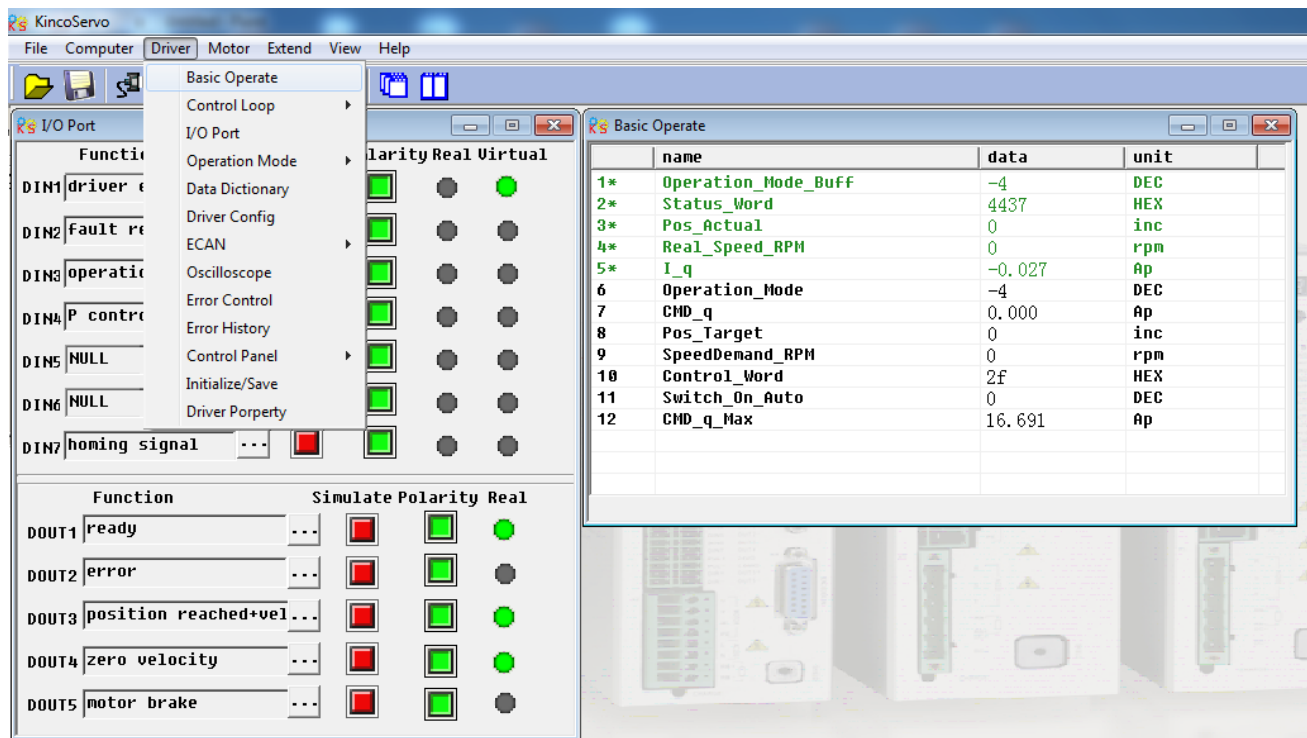




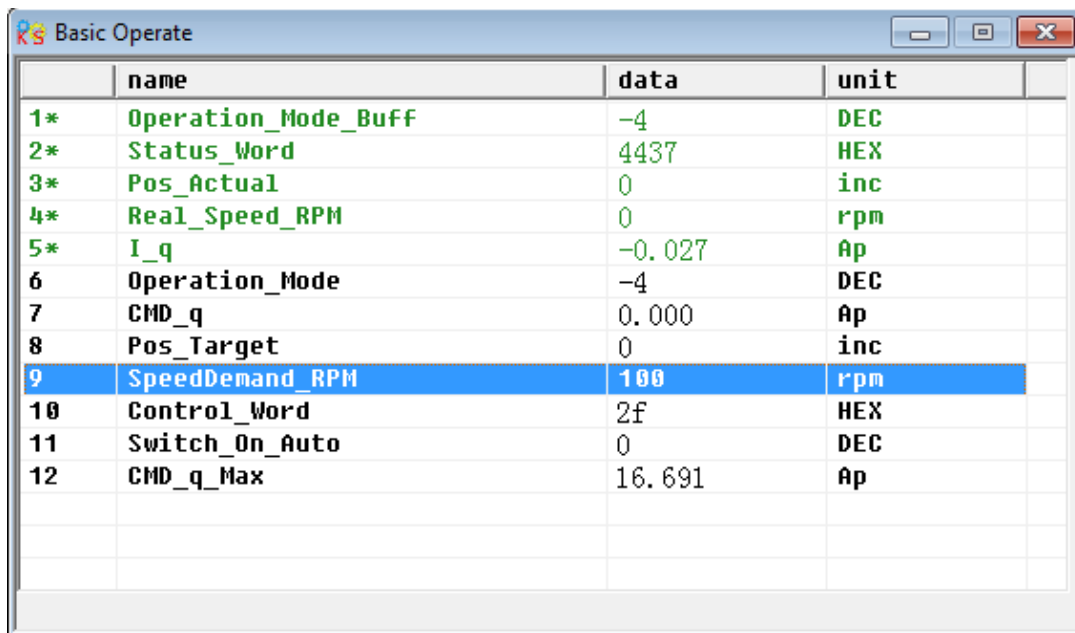
6. Cancel positive limit and negative limit. Then enable driver.




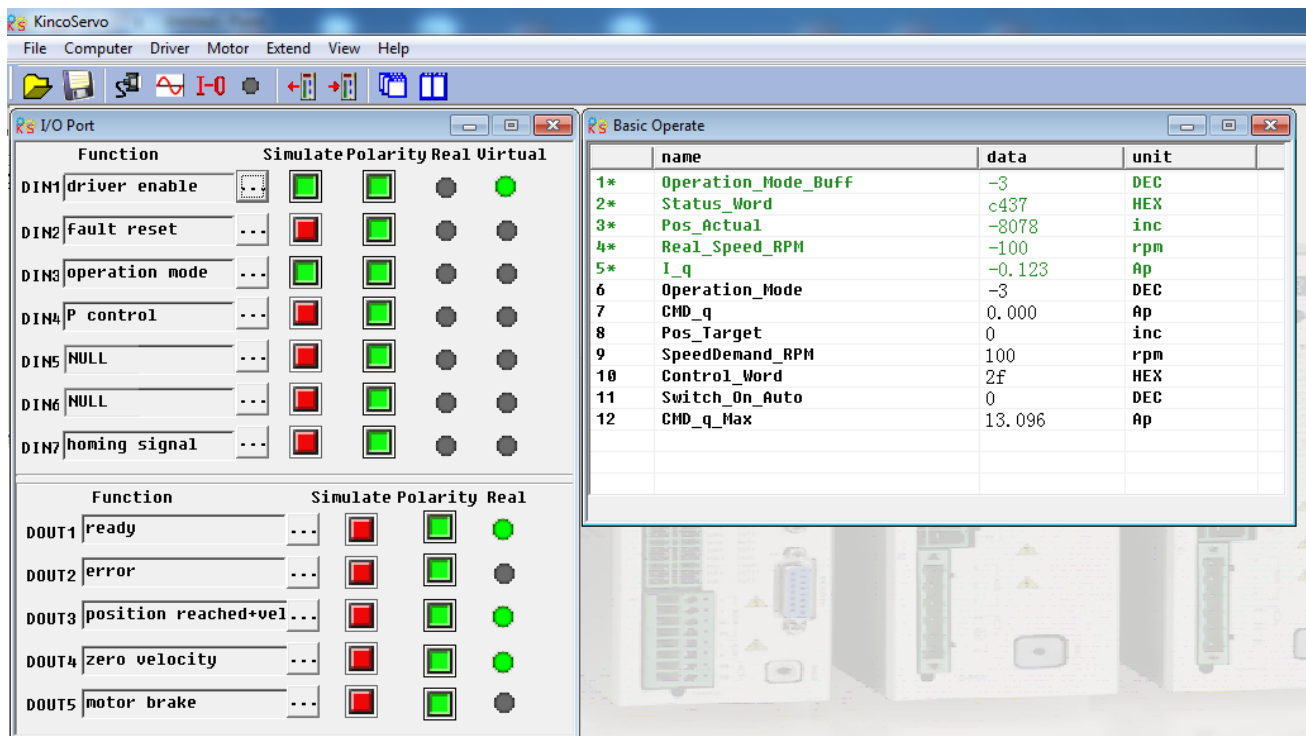
7.Click “Driver” in menu bar and select “Basic Operate”.



8.Set Speeddemand_RPM as 100RPM in “Basic Operate” window.



9. Enter  window, then simulate “operatio mode”.



The screenshot shows the KincoServo software interface. The main window has a menu bar (File, Computer, Driver, Motor, Extend, View, Help) and a toolbar. Two sub-windows are open:

- I/O Port:** This window displays digital input (DIN) and output (DOUT) signals. It has columns for 'Function', 'Simulate', 'Polarity', 'Real', and 'Virtual'.

Function	Simulate	Polarity	Real	Virtual
DIN1 driver enable	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
DIN2 fault reset	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DIN3 operation mode	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DIN4 P control	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DIN5 NULL	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DIN6 NULL	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DIN7 homing signal	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Function	Simulate	Polarity	Real
DOUT1 ready	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DOUT2 error	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
DOUT3 position reached+vel...	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DOUT4 zero velocity	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DOUT5 motor brake	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
- Basic Operate:** This window displays a table of motor parameters and their current values.

	name	data	unit
1*	Operation_Mode_Buff	-3	DEC
2*	Status_Word	c437	HEX
3*	Pos_Actual	-8078	inc
4*	Real_Speed_RPM	-100	rpm
5*	I_q	-0.123	Ap
6	Operation_Mode	-3	DEC
7	CMD_q	0.000	Ap
8	Pos_Target	0	inc
9	SpeedDemand_RPM	100	rpm
10	Control_Word	2f	HEX
11	Switch_On_Auto	0	DEC
12	CMD_q_Max	13.096	Ap

At this moment, the motor will run at 100RPM. The trial operation is finished.

Chapter 5 Operation Mode

5.1 IO Function

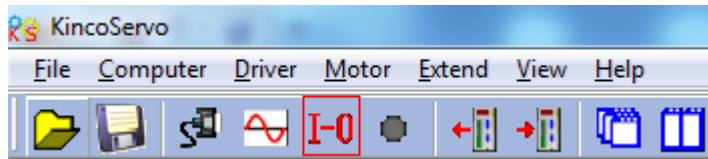
CD120 series servo driver supports 7 digital inputs and 2 digital outputs

4 channels of these digital inputs can be user-defined

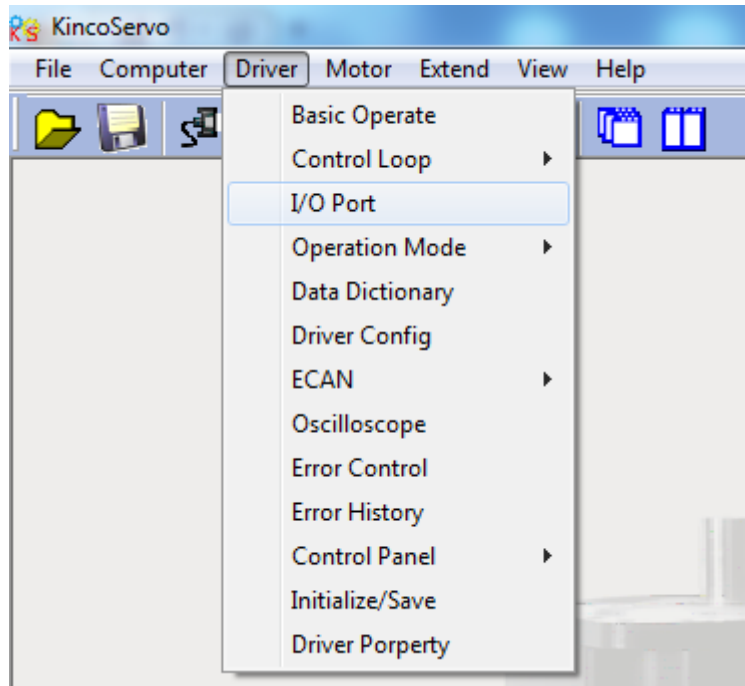
The 2 digital outputs can be user-defined.

There are two ways to open I/O port.

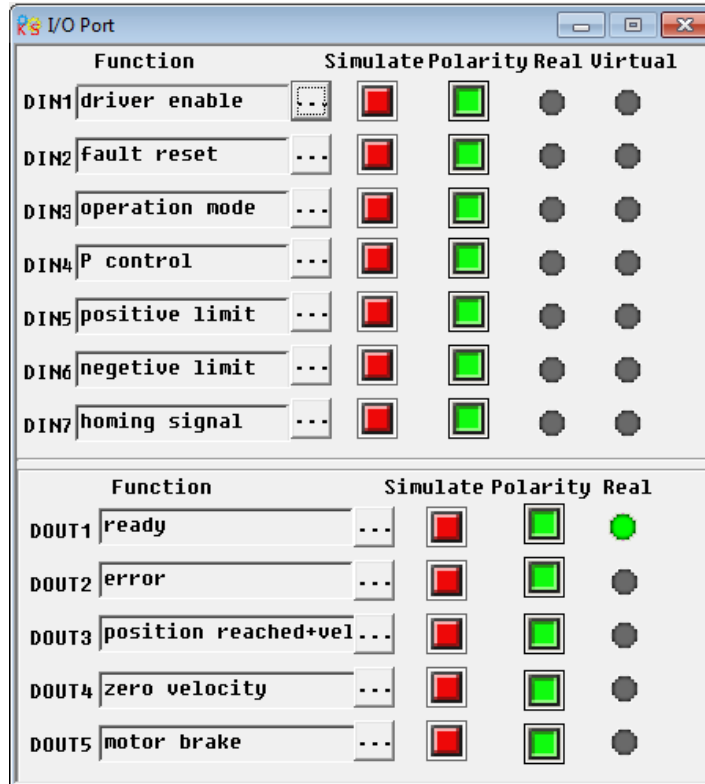
(1) Select in toolbar.



(2) Select in menu.




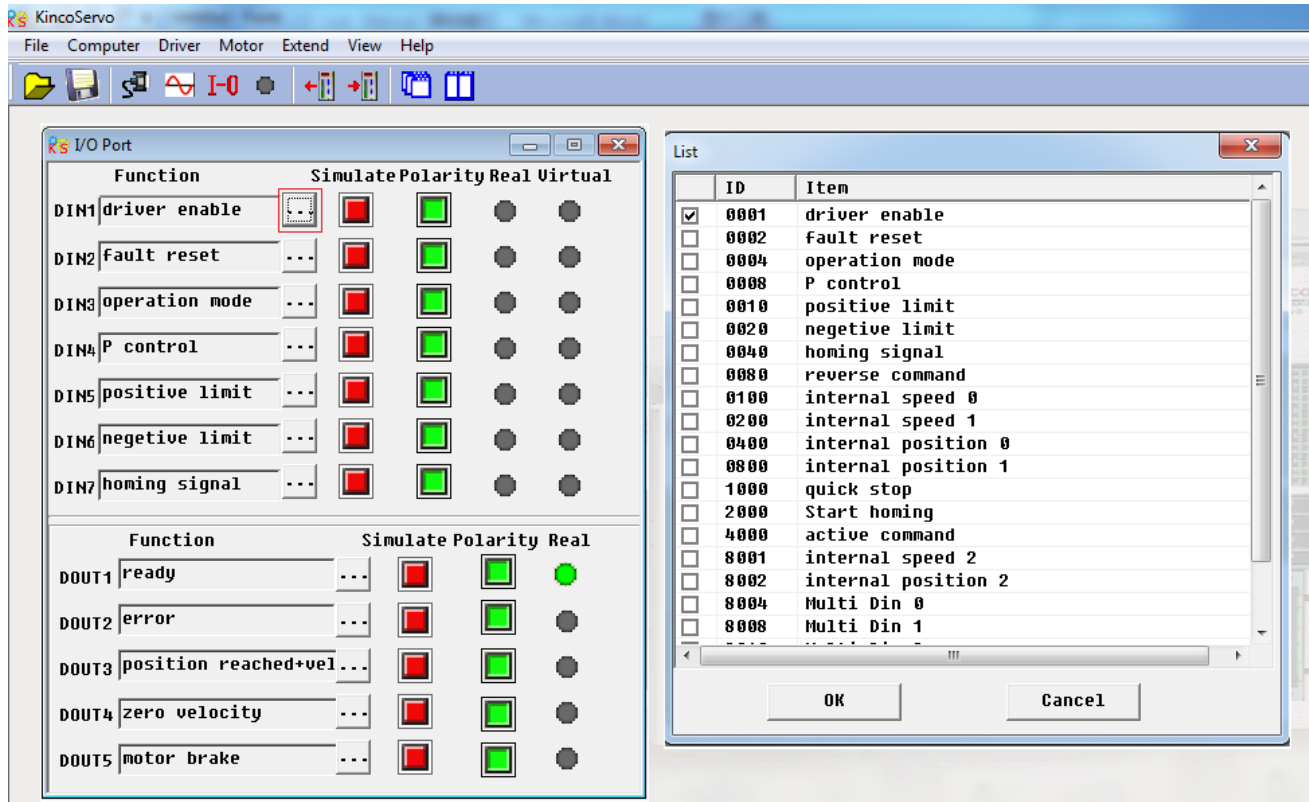
Then popup window as following figure:



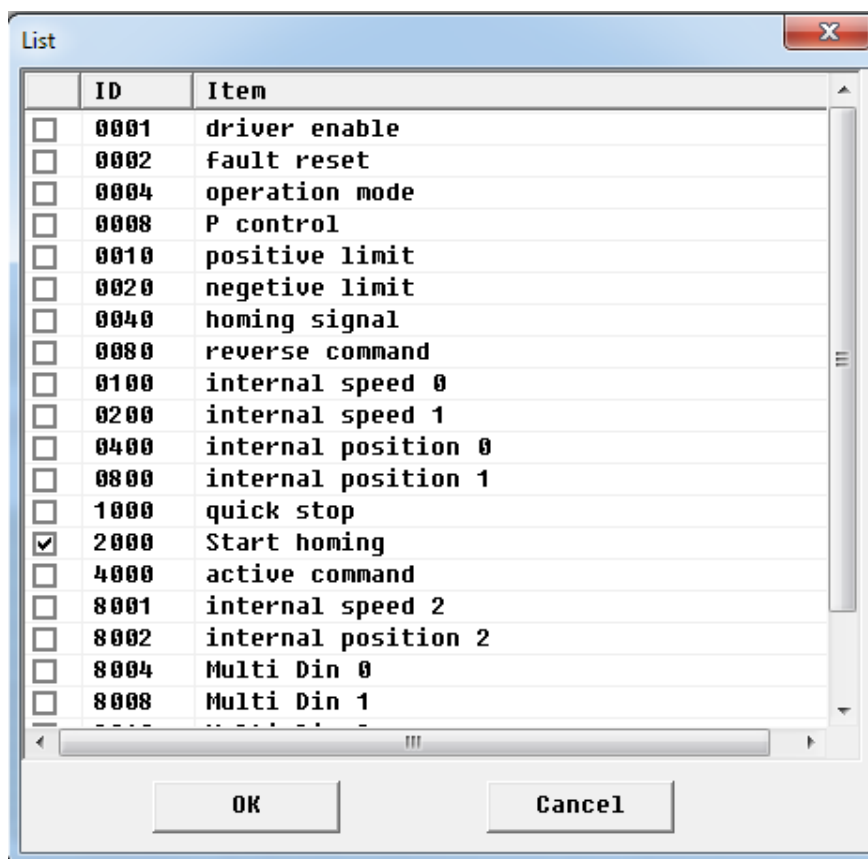
Above are the default settings, users can define the functions of I/O ports according to the requirement.

Example 5-1: Define the function of DIN1 as “Start homing”.

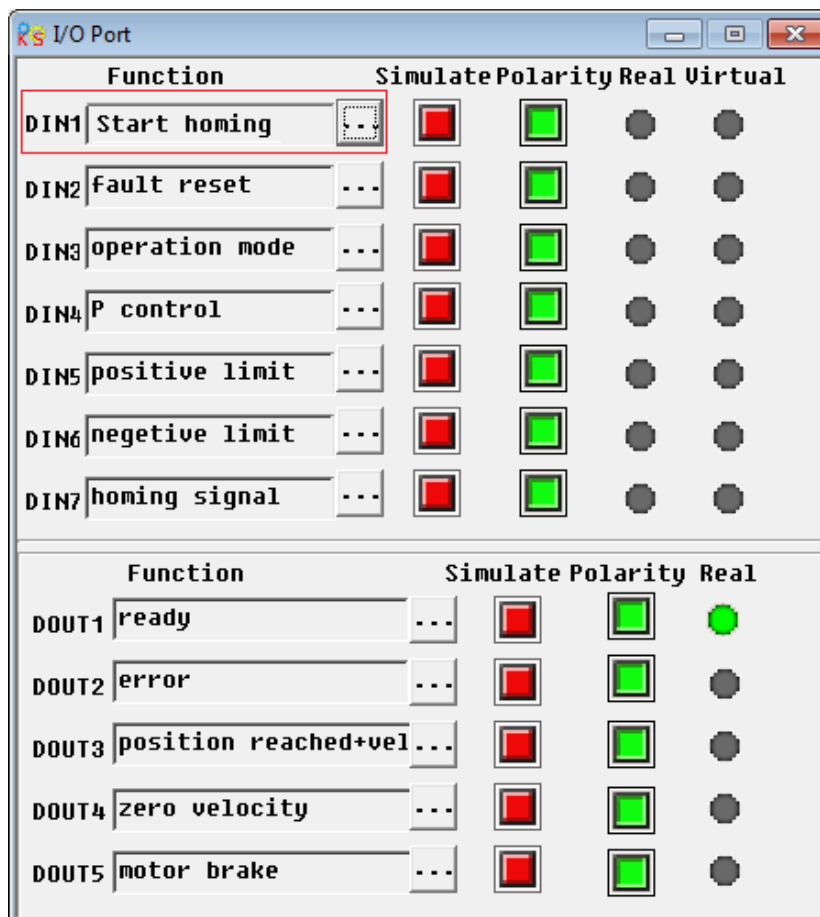
1. Click icon  of DIN1, then popup window “List”.



2. In the window “List”, cancel the function “driver enable” and select function “Start homing”, then click “OK”.



3.The the function in DIN1 has changed as “Start homing”.



Set DIN1~4 and DOUT1~2 by the same way.

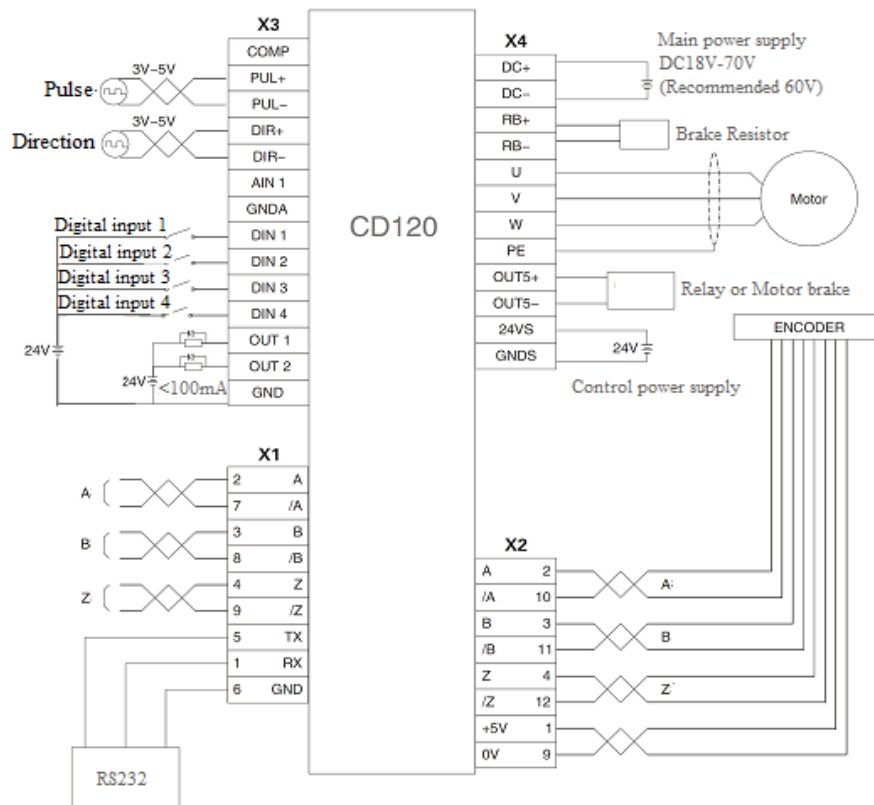
5.2 Operation Mode

CD120 supports 6 kinds of operation modes as shown in following table.

Operation mode		Value	Descriptions
Pulse mode		-4	Driver receives pulse command to control motor running to target position.
Speed mode	With acceleration/deceleration	3	Driver receives signal from digital input or analog input to control motor running at target speed.
	Without acceleration/deceleration	-3	
Internal position mode		1	Driver receives digital input signal to control motor running to target position.
Torque mode		4	Driver receives analog signal to control motor's target torque.
Homing mode		6	Driver receives digital input signal To control motor to start homing. There are 35 types of homing method.

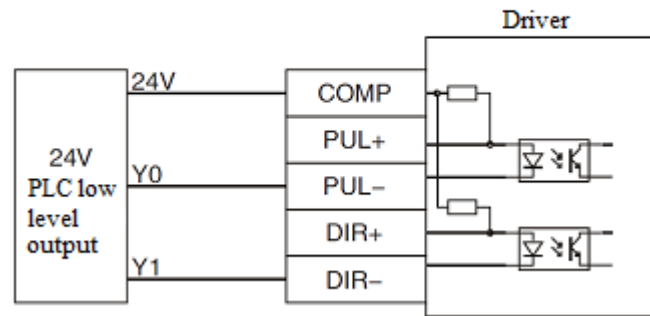
5.2.1 Pulse Mode (Mode -4)

1.Wiring Diagram



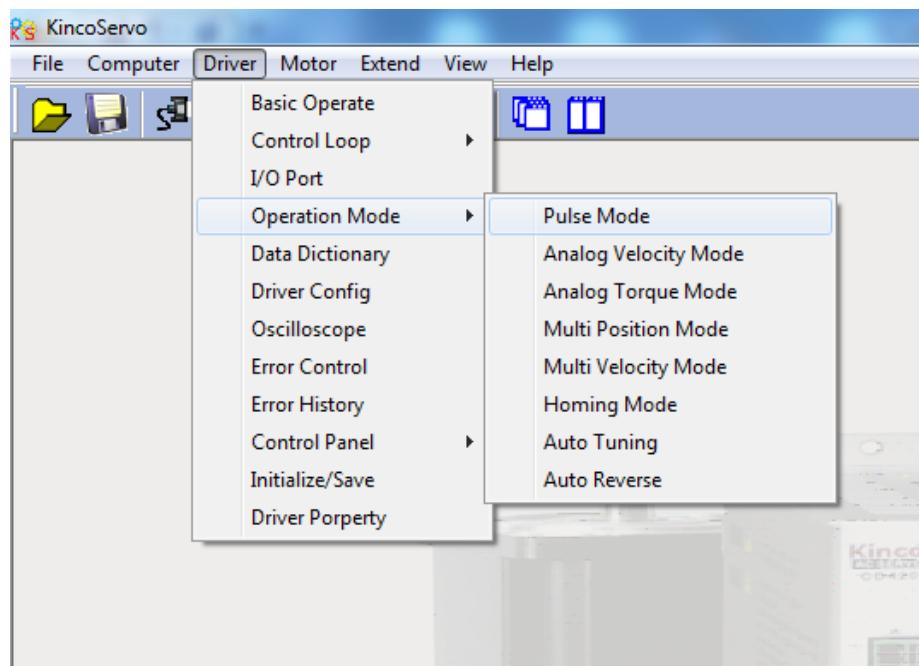
Common anode connection (For controllers that support low level output)

Use 24VDC for pulse input



2.Parameters Setting

Enter pulse mode window



Follows are the descriptions of parameters in pulse mode.

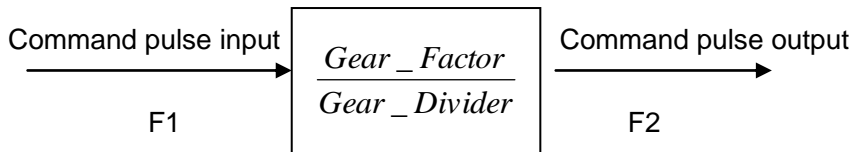
The screenshot shows the 'Pulse Mode' window in the KincoServo software. It contains a table with the following parameters:

	name	data	unit
1*	Master_Speed	0	DEC
2	Gear_Master	0	DEC
3	Gear_Slave	0	DEC
4	Gear_Factor	1000	DEC
5	Gear_Divider	1000	DEC
6	PD_CW	1	DEC
7	PD_Filter	3	DEC
8	Frequency_Check	600	DEC

2.1 Parameters for electronic gear ratio

Variable Name	Meaning	Default Value	Range
Gear_Factor	Indicates the numerator to set electronic gears in the “-4” operation mode	1000	-32767~32767
Gear_Divider	Indicates the denominator to set electronic gears in the “-4” operation mode	1000	1~32767

Parameters for electronic gear ratio are used to set the numerator and denominator of electronic gears when the driver operates in the “-4” mode.



Namely: $F2 = \frac{Gear_Factor}{Gear_Divider} * F1$

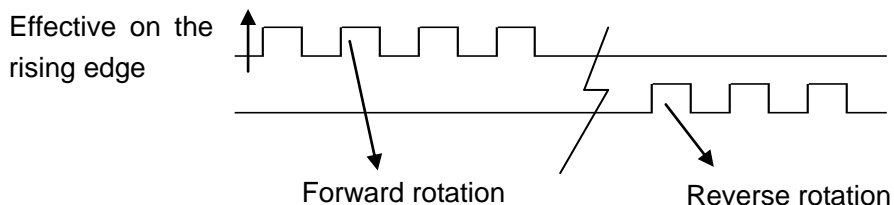
If the electronic gear ratio is 1:1, 10000 pulses are inputted externally (the resolution of encoders is 2500 PPR, quadruple), and the motor turns a circle. If the electronic gear ratio is 2:1, 5000 pulses are inputted externally, and the motor turns a circle.

2.2 Parameters for pulse mode selection

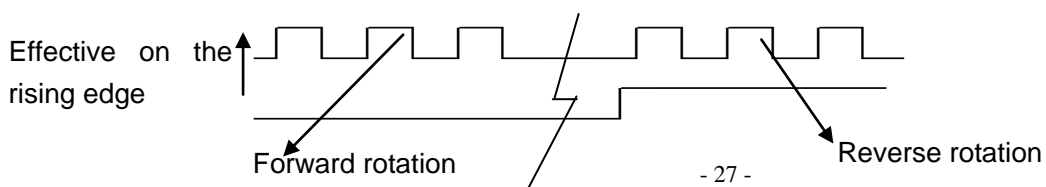
Variable Name	Meaning	Default Value	Range
PD_CW	0: Double pulse (CW/CCW) mode 1: Pulse direction (P/D) mode Note: To change this parameter, you need to save it with d3.00, and restarts it later.	1	N/A

Note: AB phase signals are not supported.

Double pulse (CW/CCW) mode (d3.36 = 0)



Pulse direction (P/D) mode (d3.36 = 1)



2.3 Parameters for pulse filtering coefficient



Variable Name	Meaning	Default Value	Range
PD_Filter	Used to smooth the input pulses. Filter frequency: $f = 1000/(2\pi * PD_Filter)$ Time constant: $T = PD_Filter/1000$ Unit: S Note: If you adjust this parameter during the operation, some pulses may be lost.	3	1~32767

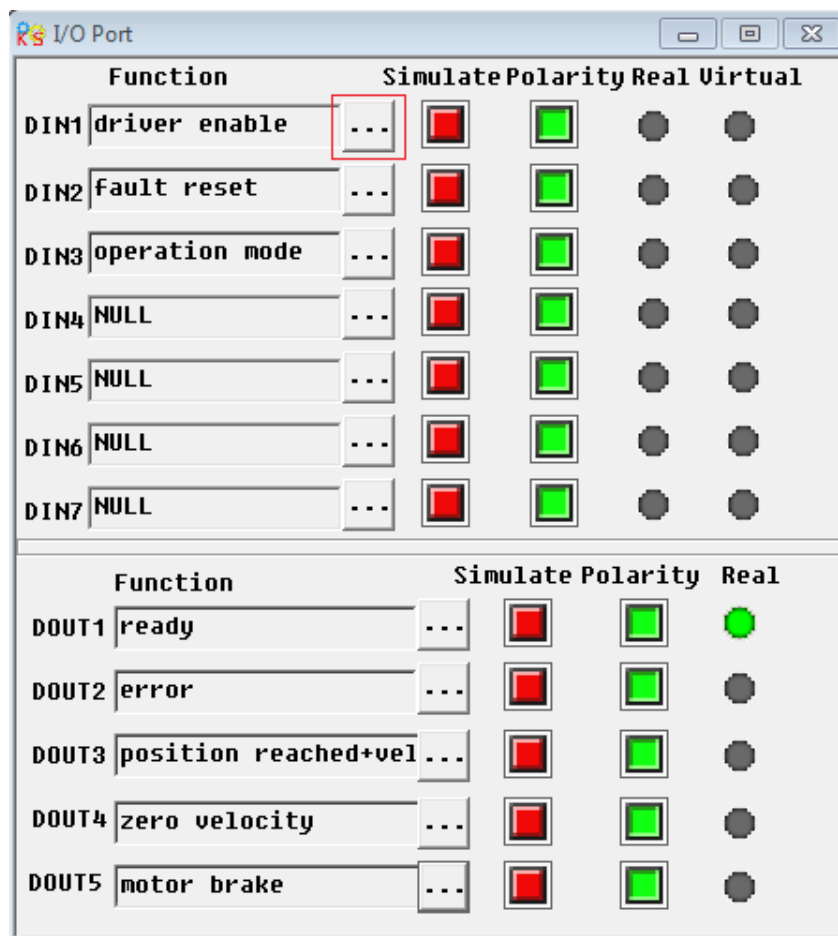
When a driver operates in the pulse control mode, if the electronic gear ratio is set too high, it is required to adjust this parameter to reduce motor oscillation; however, if the parameter adjustment is too great, motor running instructions will become slower.

3.Example for pulse control mode

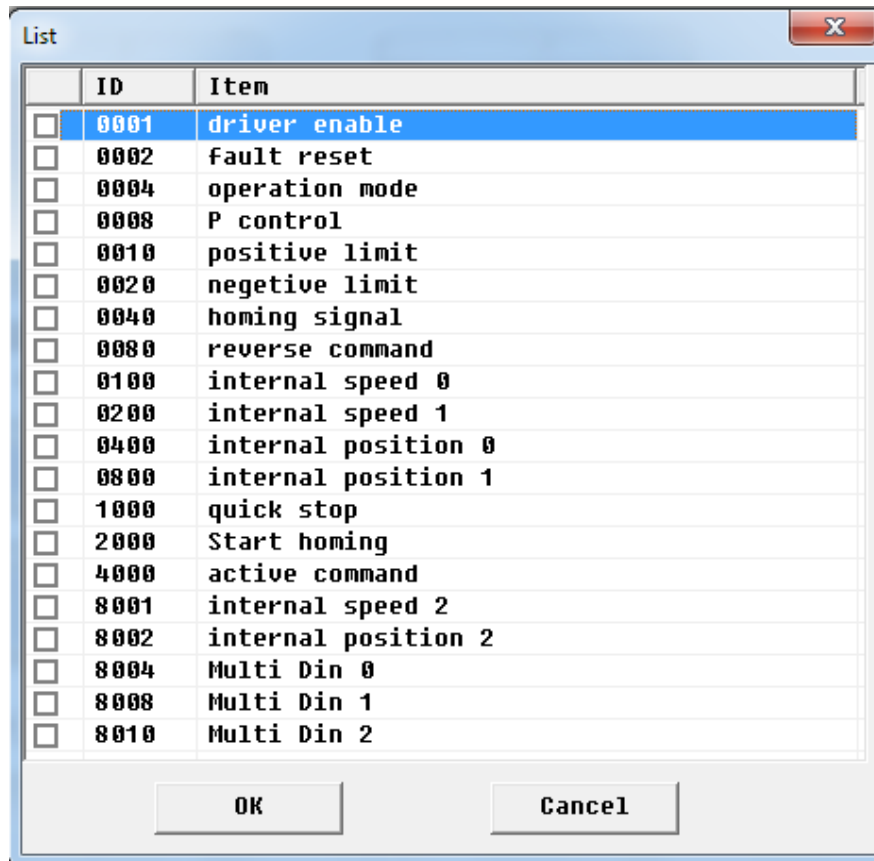
Example 5-2:Require driver enable automatically after power on.Use pulse/direction mode and 20000 pulse for running a cycle.

Procedure:

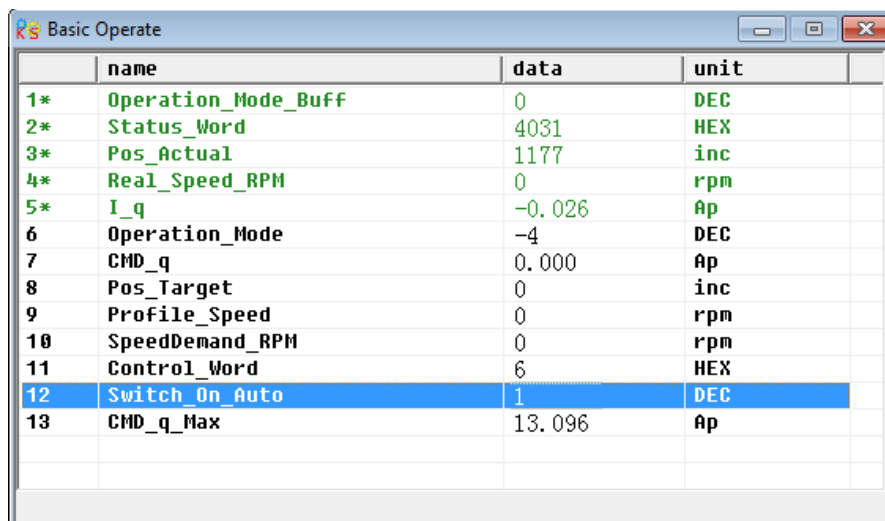
- (1) Click icon , then click icon  in DIN1.



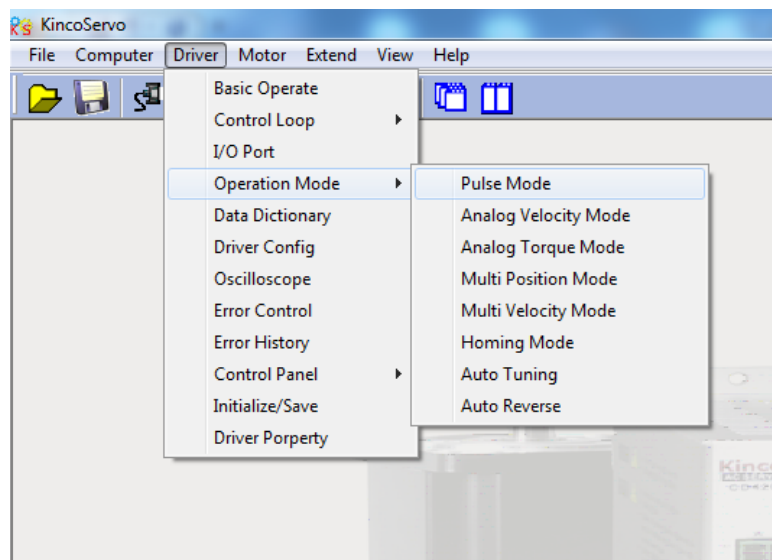
(2) Cancel function “driver enable”.



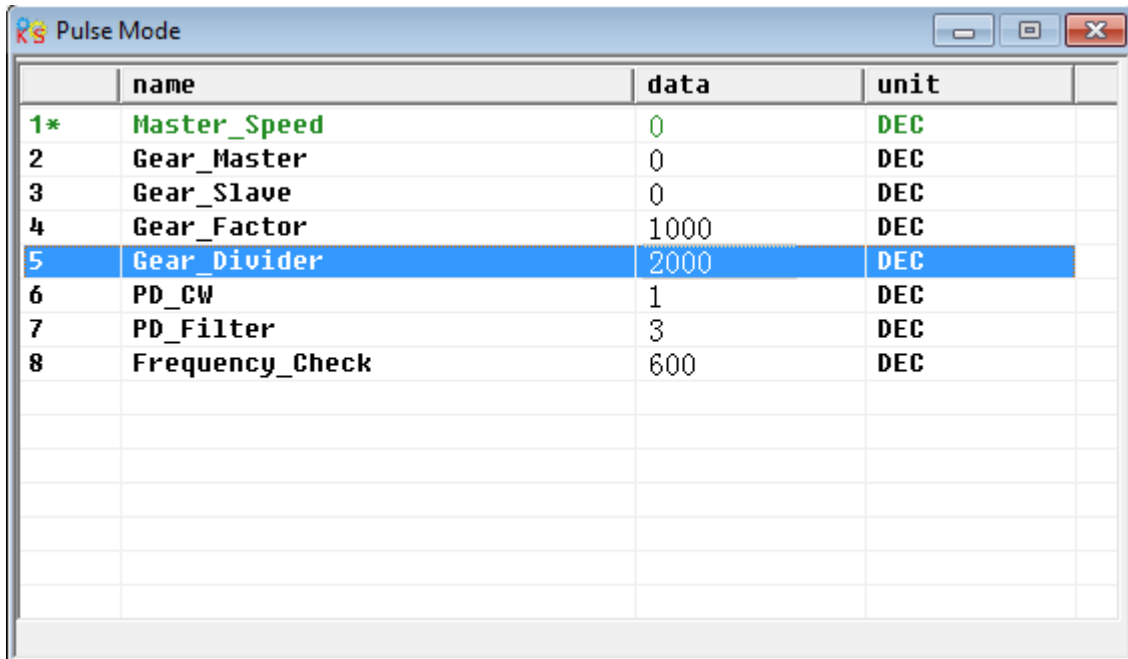
(3) Enter “Basic Operate” window, then set “Switch_On_Auto” as 1.



(4) Enter “Pulse Mode”.



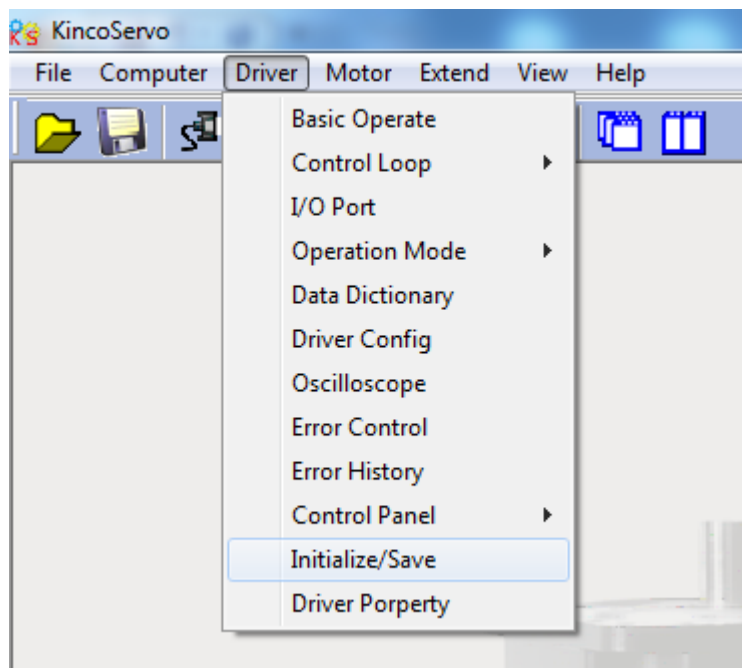
(5) Set electronic gear:Gear_Factor as 1000,Gear_Divider as 2000,and others as default.



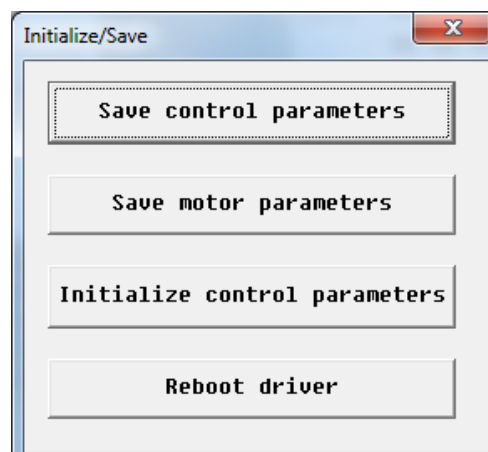
The screenshot shows a window titled "Pulse Mode" with a table of parameters. The table has four columns: an index column, a "name" column, a "data" column, and a "unit" column. The "Gear_Divider" parameter at index 5 is highlighted in blue.

	name	data	unit
1*	Master_Speed	0	DEC
2	Gear_Master	0	DEC
3	Gear_Slave	0	DEC
4	Gear_Factor	1000	DEC
5	Gear_Divider	2000	DEC
6	PD_CW	1	DEC
7	PD_Filter	3	DEC
8	Frequency_Check	600	DEC

(6) Enter "Initialize/Save" window.



(7) Click "Save control parameters" to save the parameters.Then the settings are finished..

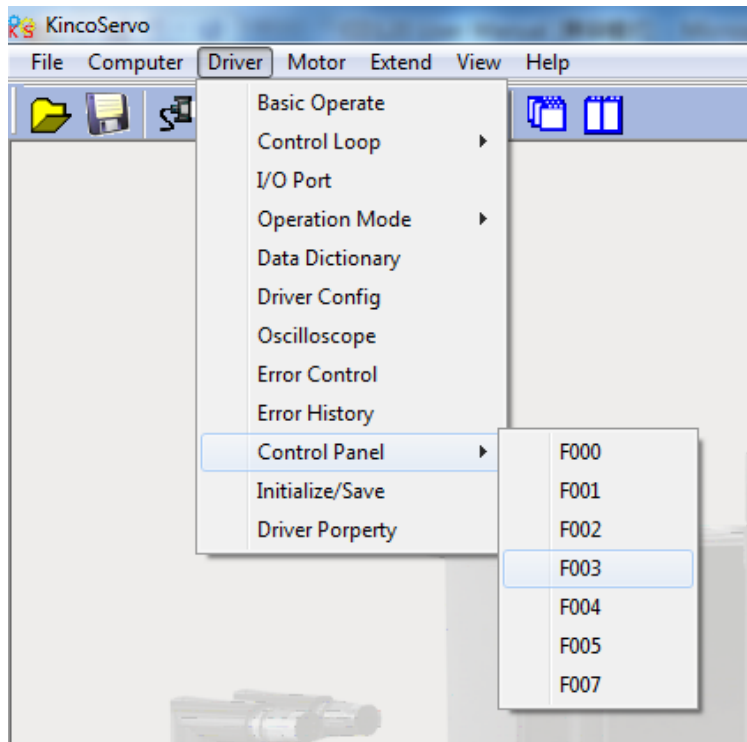


5.2.2 Speed Mode (Mode 3 and -3)

-3	Speed mode without acceleration and deceleration
3	Speed mode with acceleration and deceleration

1.Control by PC software.

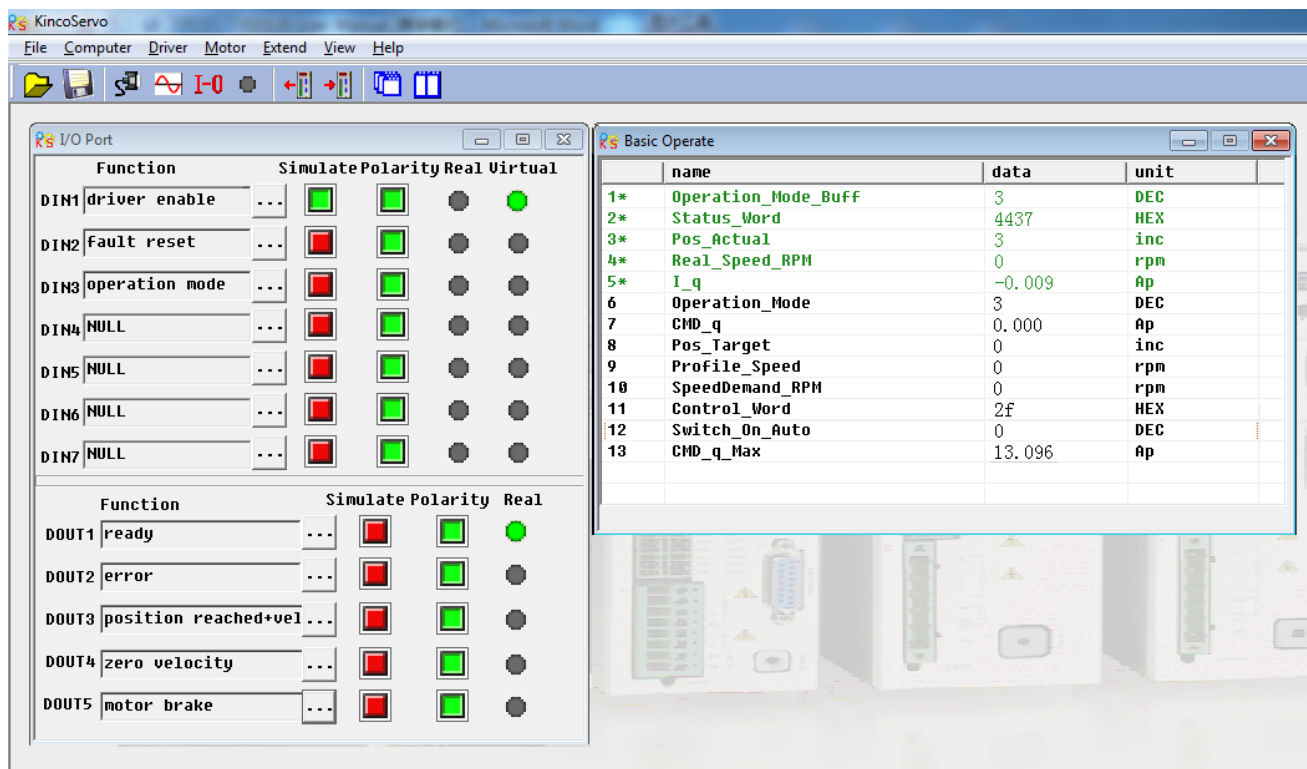
1.1 Enter F003 window.



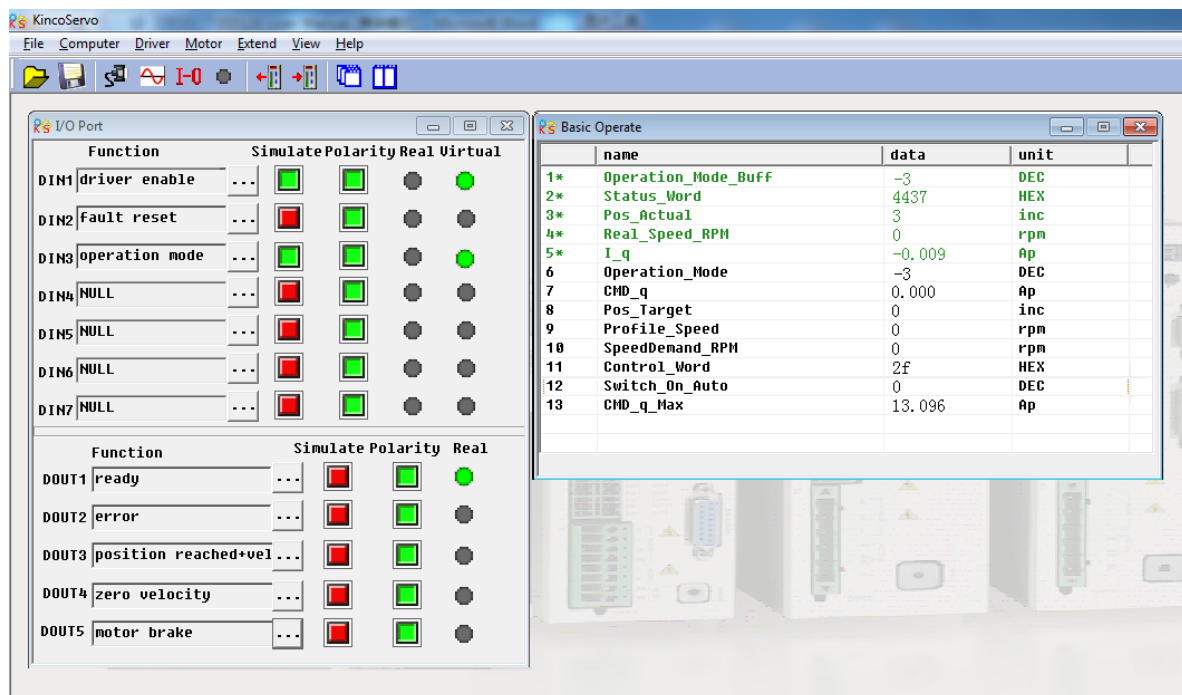
1.2 Change the 16th parameter in F003(Din_Mode0) as 3.

	name	data	unit
5	Din5_Function	0	HEX
6	Din6_Function	0	HEX
7	Din7_Function	0	HEX
8	Dio_Polarity	0	Hex
9	Dio_Simulate	0	Hex
10	Switch_On_Auto	0	DEC
11	Dout1_Function	1	HEX
12	Dout2_Function	2	HEX
13	Dout3_Function	a4	HEX
14	Dout4_Function	8	HEX
15	Dout5_Function	10	HEX
16	Din_Mode0	3	DEC
17	Din_Mode1	-3	DEC
18	Din_Speed0_RPM	0	rpm
19	Din_Speed1_RPM	0	rpm

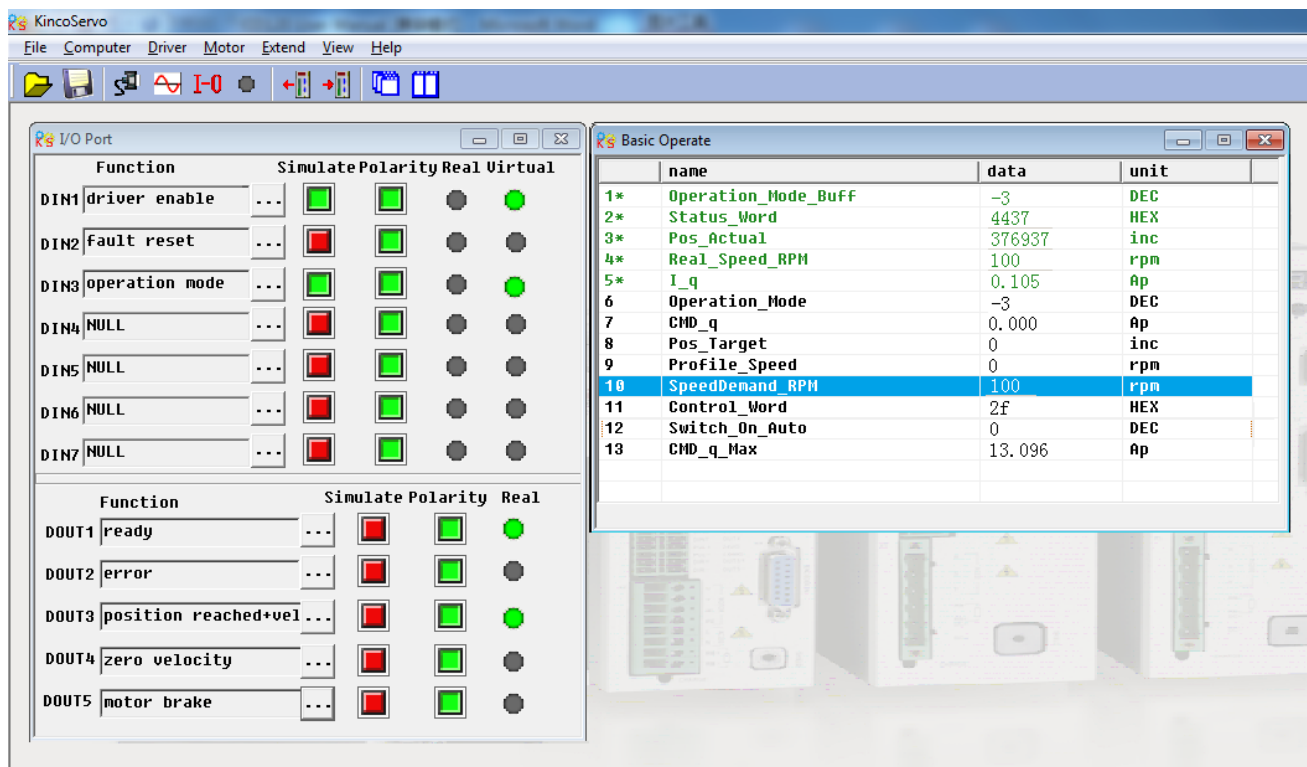
1.3 Simulate the “drive enable” function,then the actual operation mode(Operation_Mode_Buff) will be changed into 3.



1.4 Simulate the “operation mode” function, then the actual operation mode will be changed into -3.

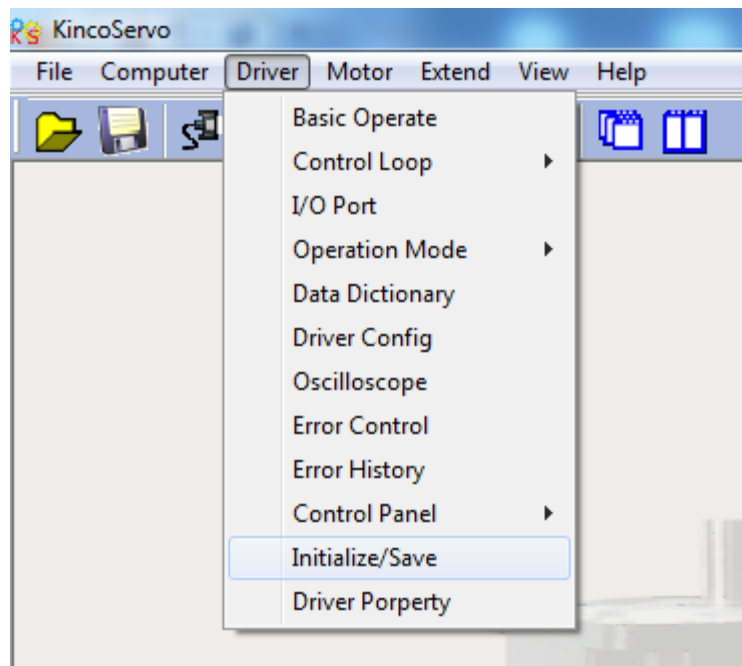


1.5 Set “SpeedDemand_RPM” as 100, then the motor will run at 100RPM.

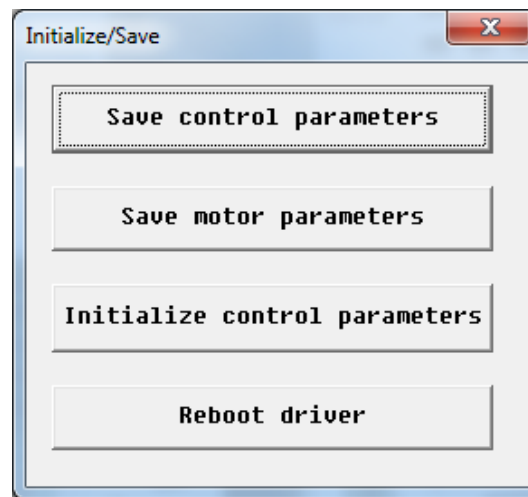


1.6 Save parameters.

- (1) Enter "Initial/save" window.

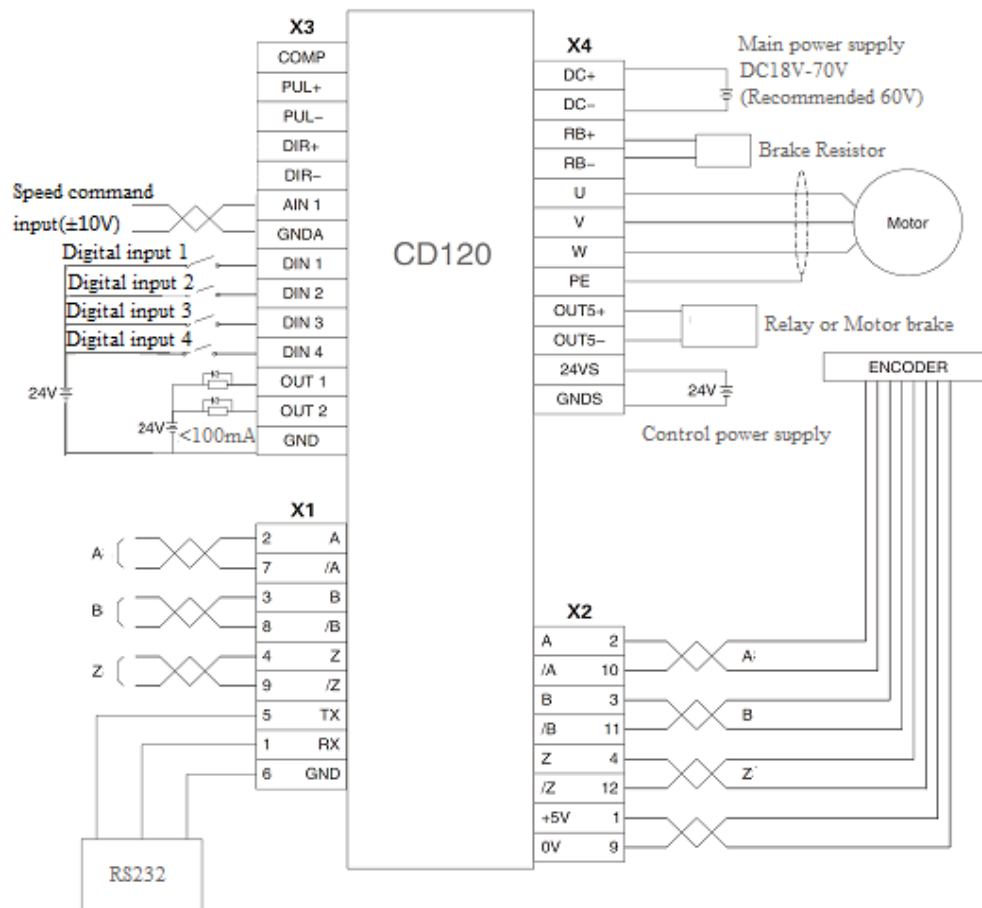


- (2) Click "Save control parameters" .



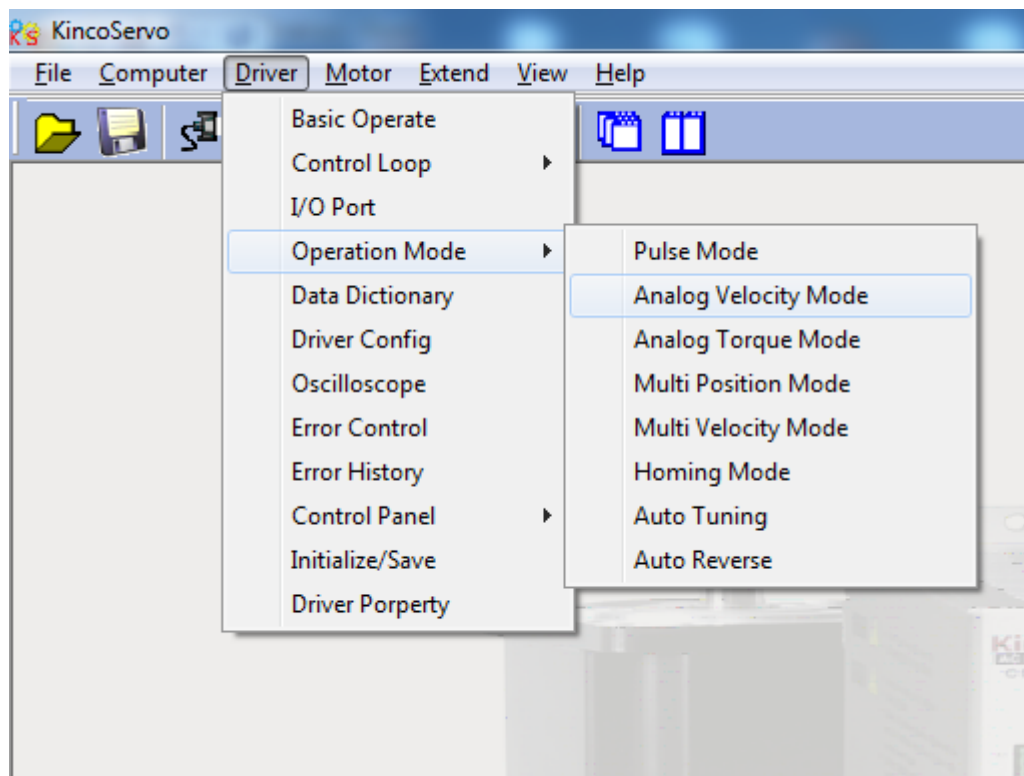
2.Control by analog input

2.1 Wiring diagram



2.2 Parameters setting

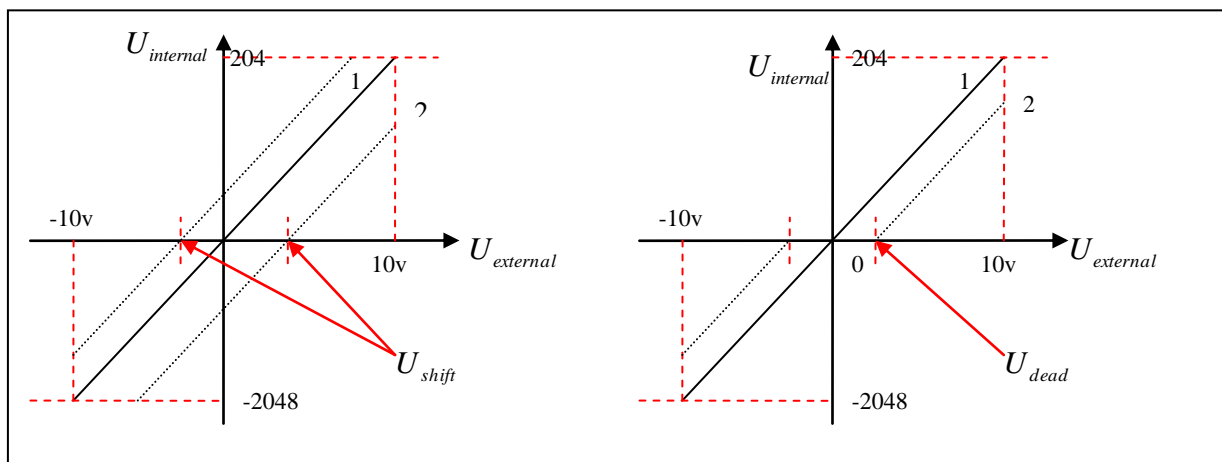
(1)Enter “Speed Velocity Mode”.



(2)Parameters description

	name	data	unit
1*	ADC1_Buff[1]	2017	DEC
2*	Analog1_out	0.020	V
3*	ADC2_Buff[1]	0	DEC
4*	Analog2_out	0.005	V
5	Analog1_Filter	5	DEC
6	Analog1_Dead	0	DEC
7	Analog1_Offset	0	DEC
8	Analog2_Filter	5	DEC
9	Analog2_Dead	0	DEC
10	Analog2_Offset	0	DEC
11	Analog_Speed_Factor	1000	DEC
12	Analog_Speed_Con	1	DEC

Variable Name	Meaning	Default Value	Range
Analog1_Filter	Used to smooth the input analog signals. Filter frequency: $f=4000/(2\pi \cdot \text{Analog1_Filter})$ Time Constant (T) = Analog1_Filter/4000 (S)	5	1~127
Analog1_Dead	Sets dead zone data for external analog signal 1	0	0~8192
Analog1_Offset	Sets offset data for external analog signal 1	0	-8192~8192
Analog2_Filter	Used to smooth the input analog signals. Filter frequency: $f=4000/(2\pi \cdot \text{Analog2_Filter})$ Time Constant (T) = Analog2_Filter/4000 (S)	5	1~127
Analog2_Dead	Sets dead zone data for external analog signal 2	0	0~8192
Analog2_Offset	Sets offset data for external analog signal 2	0	-8192~8192
Analog_Speed_Con	Selects analog-speed channels 0: Invalid analog channel 1: Valid analog channel 1 (AIN1) 2: Valid analog channel 2 (AIN2) Valid mode -3 and mode 3	0	N/A
Analog_Speed_Factor	Sets the proportion between analog signals and output speed	1000	N/A
Analog_MaxT_Con	0: No control 1: Max torque that Ain1 can control 2: Max torque that Ain2 can control	0	N/A
Analog_MaxT_Factor	Indicates the max torque factor for analog signal control	8192	N/A



Electrical control on internal variables is available only after ADC conversion and offset of external analog signals, and judgment of dead zone signals.

For offset processing, see the left part in the figure above; for dead zone processing, see the right part in the figure above.

Mathematical equation for offset processing: $U_{internal} = U_{external} - U_{shift}$

$$\begin{cases} U_{internal} = 0 \dots \dots \dots -U_{dead} \leq U_{external} \leq U_{dead} \\ U_{internal} = U_{external} - U_{dead} \dots \dots \dots \end{cases} \begin{cases} -U_{dead} > U_{external} \\ U_{dead} < U_{external} \end{cases}$$

Mathematical equation for dead zone processing:

Mathematical equation for integrated processing (offset and dead zone)

$$\begin{cases} U_{internal} = 0 \dots \dots \dots -U_{dead} \leq U_{external} - U_{shift} \leq U_{dead} \\ U_{internal} = U_{external} - U_{shift} - U_{dead} \dots \dots \dots \end{cases} \begin{cases} -U_{dead} > U_{external} - U_{shift} \\ U_{dead} < U_{external} - U_{shift} \end{cases}$$

Variable	Meaning	Range
$U_{internal}$	Internal data corresponding to the external voltage	-10 V – 10 V corresponds to -2048 – 2047 when no offset or dead zone voltage exists
$U_{external}$	External input voltage	-10V – 10V
U_{shift}	Offset voltage	0 – 10 V corresponds to <i>Analog_Offset</i> 0~8191
U_{dead}	Dead zone voltage	0 – 10 V corresponds to <i>Analog_Dead</i> 0~8191

The obtained analog signal $U_{internal}$ obtains U_{filter} after passing through a first-order low-pass filter, and is applied by the internal programs again.

In the analog – speed mode, if the analog signal U_{filter} that passes through the filter is multiplied by a factor, this signal will be regarded as the internal target speed V_{demand} .

Mathematical formula: $V_{demand} = Factor * U_{filter} \dots \dots -2048 \leq U_{filter} \leq 2047$

V_{demand} Formula for V_{rpm} conversion: $V_{rpm} = \frac{1875 * V_{demand}}{512 * Encoder_R}$

Note: The resolution unit of an encoder is inc/r.

In summary, the calculation procedure for analog – speed mode is as following table:

Procedure	Method	Formula
Step 1	Calculate U_{filter} according to the offset voltage and dead zone voltage that require settings	$U_{filter} = \frac{2047}{10v} * (10v - U_{shift} - U_{dead})$

Step 2	Calculate V_{demand} according to the required speed V_{rpm}	$V_{demand} = \frac{512 * Encoder_R}{1875} * V_{rpm}$
Step 3	Calculate $Factor$ according to U_{filter} and V_{demand}	$Factor = V_{demand} / U_{filter}$
Step 5	Calculate $Analog_Dead$ according to the required dead zone voltage	$Analog_Dead = \frac{8191}{10v} * U_{dead}$
Step 5	Calculate $Analog_Offset$ according to the required offset voltage	$Analog_Offset = \frac{8191}{10v} * U_{shift}$

3.Internal Multi-velocity mode

3.1 Mode description

This model uses DIN signal to control motor running at preset target velocity .

Note:

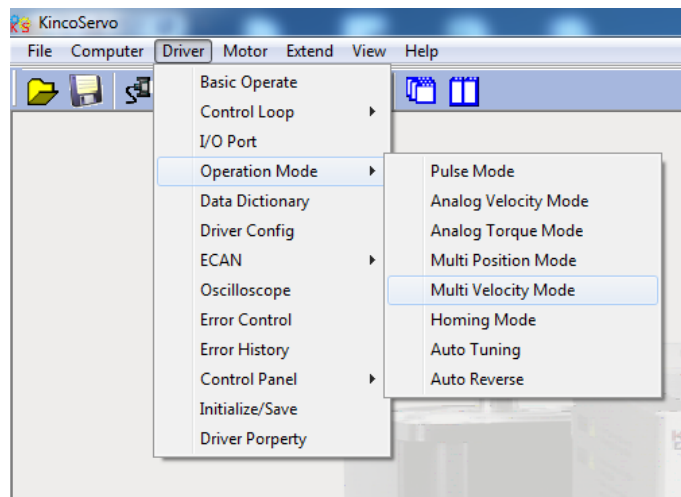
1. Multiple velocity control can only work in mode -3 and 3.
2. The parameter d3.28(Analog_Speed Con) must set as 0.
3. At least one of the DIN function(DinX_Function) is set as Internal speed 0,Internal speed 1 or Internal speed 2.

Parameters for internal multi-speed control mode

Internal speed 0	Internal speed 1	Internal speed 2	Meaning
0	0	0	Din_Speed 0[rpm]
1	0	0	Din_Speed 1[rpm]
0	1	0	Din_Speed 2[rpm]
1	1	0	Din_Speed 3[rpm]
0	0	1	Din_Speed 4[rpm]
1	0	1	Din_Speed 5[rpm]
0	1	1	Din_Speed 6[rpm]
1	1	1	Din_Speed 7[rpm]

3.2 Example 5-4: Set DIN4 to control 2 internal speeds. Speed 1 is 100rpm and speed 2 is 500rpm. Select speed 1 when DIN4 is OFF, and select speed 2 when DIN4 is ON.

1. Select “Multi Velocity Mode”.

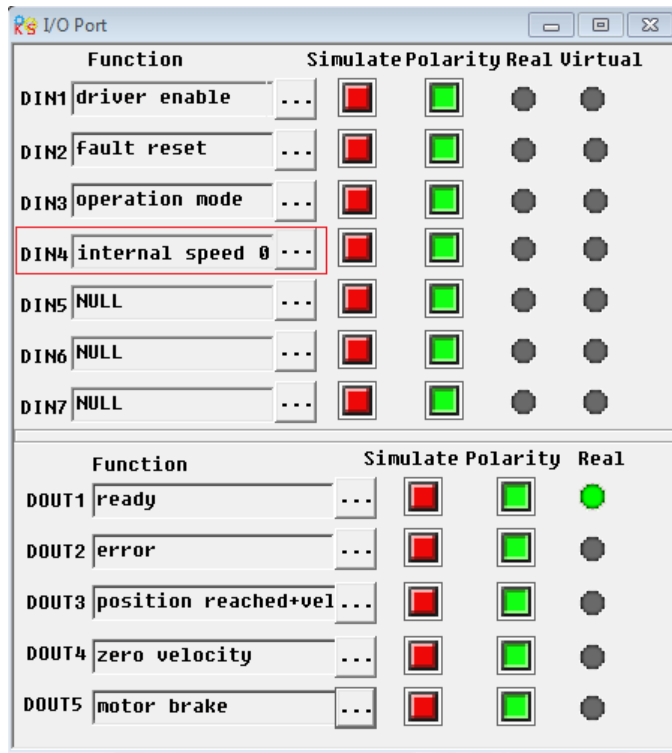


2. Set “Din_Speed” as following figure.

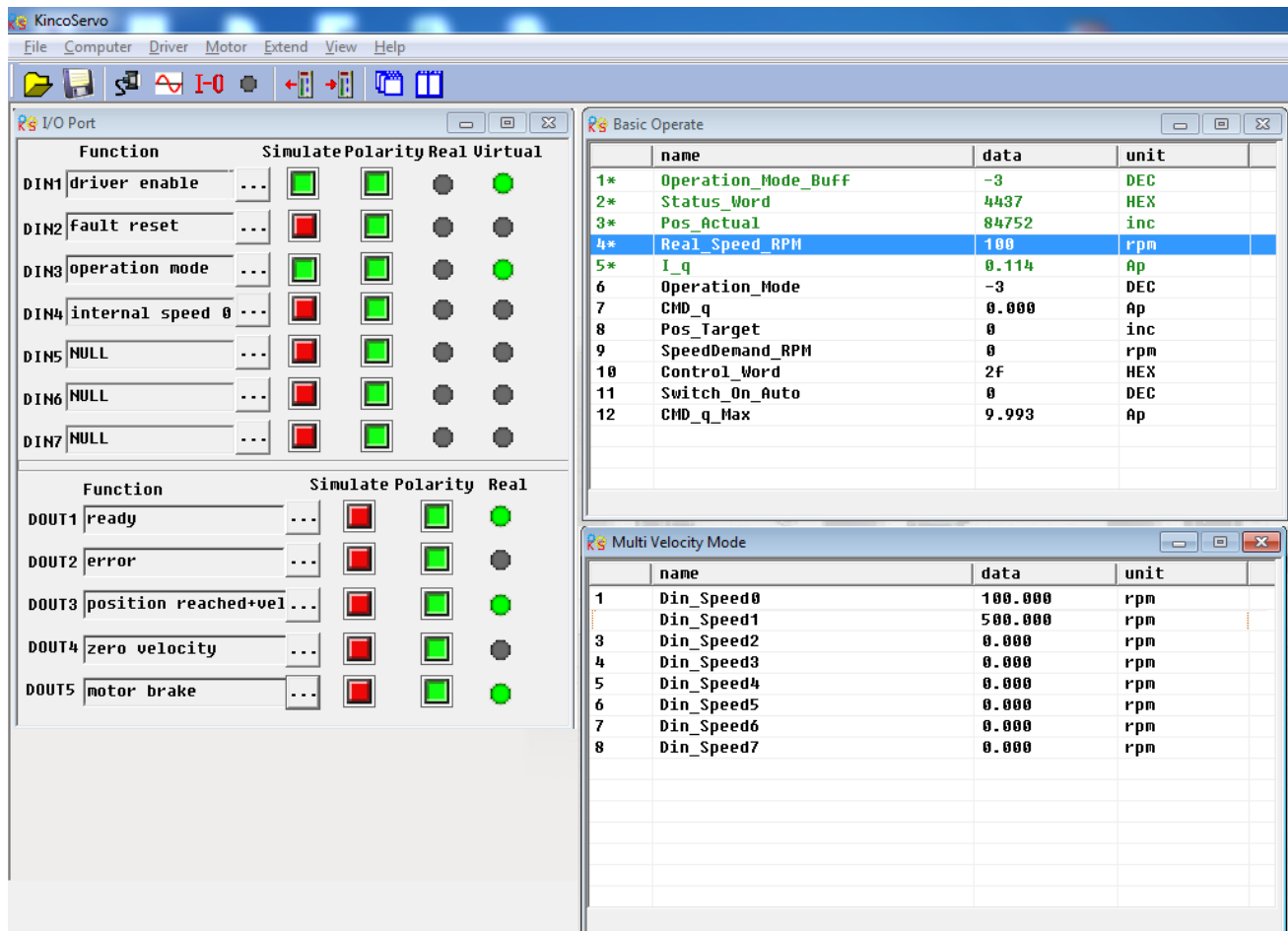
The screenshot shows the 'Multi Velocity Mode' configuration window. It contains a table with 4 columns: 'name', 'data', and 'unit'. The table lists 8 speed settings, with 'Din_Speed1' highlighted in blue.

	name	data	unit
1	Din_Speed0	100.000	rpm
2	Din_Speed1	500.000	rpm
3	Din_Speed2	0.000	rpm
4	Din_Speed3	0.000	rpm
5	Din_Speed4	0.000	rpm
6	Din_Speed5	0.000	rpm
7	Din_Speed6	0.000	rpm
8	Din_Speed7	0.000	rpm

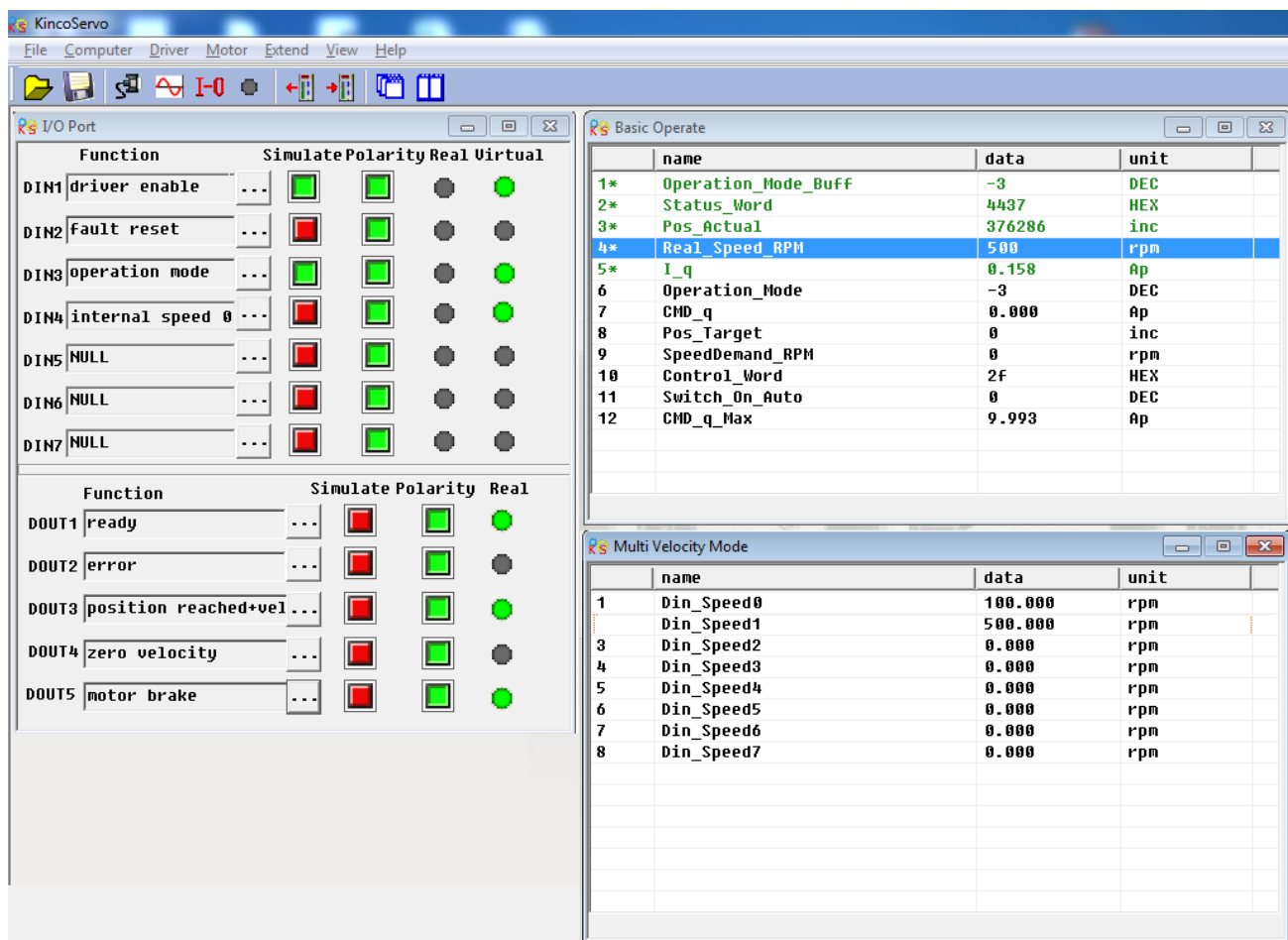
3. Set the function of DIN4 as “Internal speed 0”.



4. Operate the I/O simulation, then observe the “Real_Speed_RPM” in Basic Operate, as shown in following figure.



5. Change the simulate of DIN4, and observe “Real_Speed_RPM”, as shown in following figure.



6. Save parameters.

5.2.3 Internal Multi-position mode (Mode 1)

1. Mode descriptions

This mode uses DIN signal to control motor running at preset target position.

Note:

1. Internal Multi-position control can only work in mode 1.
2. At least one of the DIN is set as "Internal position 0", "Internal position 1" or "Internal position 2"

Internal Multi-position Control Mode Parameter Table

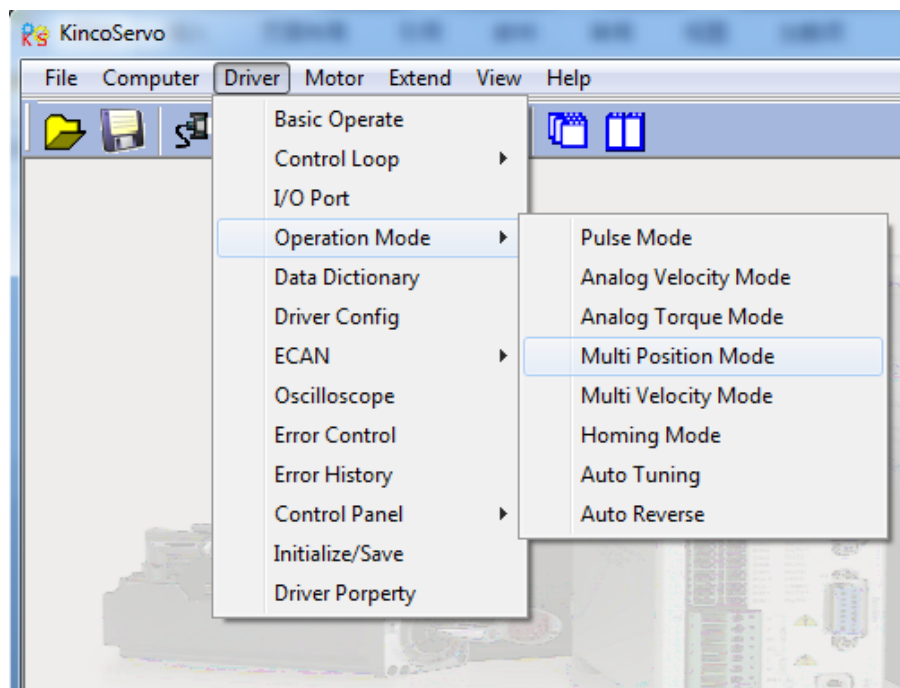
Internal position 0	Internal position 1	Internal position 2	Corresponding position (inc)	Corresponding speed
0	0	0	Din_Pos0	Din_Speed0_RPM
0	0	1	Din_Pos1	Din_Speed1_RPM
0	1	0	Din_Pos2	Din_Speed2_RPM

0	1	1	Din_Pos3	Din_Speed3_RPM
1	0	0	Din_Pos4	Din_Speed4_RPM
1	0	1	Din_Pos5	Din_Speed5_RPM
1	1	0	Din_Pos6	Din_Speed6_RPM
1	1	1	Din_Pos7	Din_Speed7_RPM

Note: Din_PosX can be set as positive and negative, but Din_SpeedX_RPM must be set as positive.

2. Operation for Internal Multi-position mode

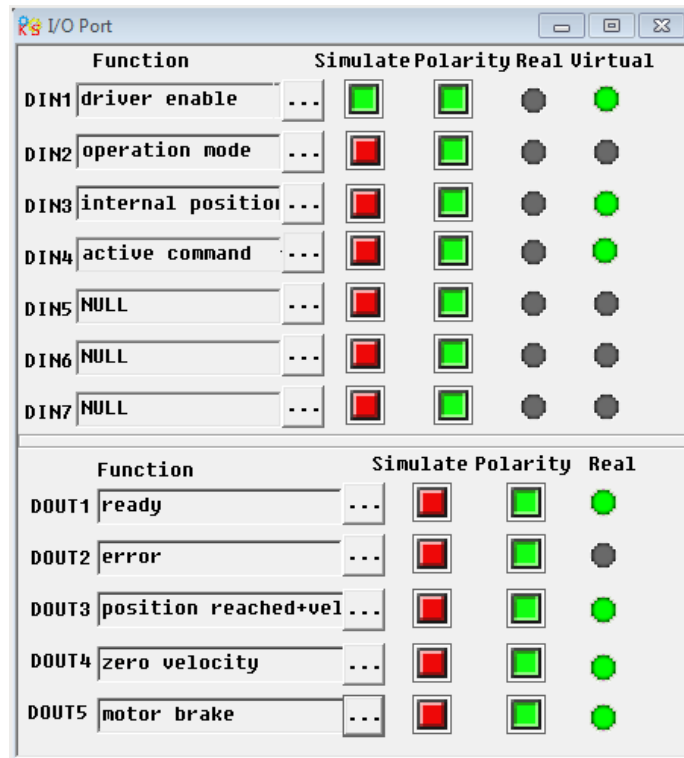
2.1 Enter Multi Position Mode.



2.2 Set Din_Pos as following figure.

	name	data	unit
2	Profile_Acce	610.352	rps/s
3	Profile_Dece	610.352	rps/s
4	Din_Pos0	50000	DEC
5	Din_Pos1	0	DEC
6	Din_Pos2	0	DEC
7	Din_Pos3	0	DEC
8	Din_Pos4	0	DEC
9	Din_Pos5	0	DEC
10	Din_Pos6	0	DEC
11	Din_Pos7	0	DEC
12	Din_Speed0	200	rpm
13	Din_Speed1	500	rpm
14	Din_Speed2	0	rpm
15	Din_Speed3	0	rpm
16	Din_Speed4		rpm

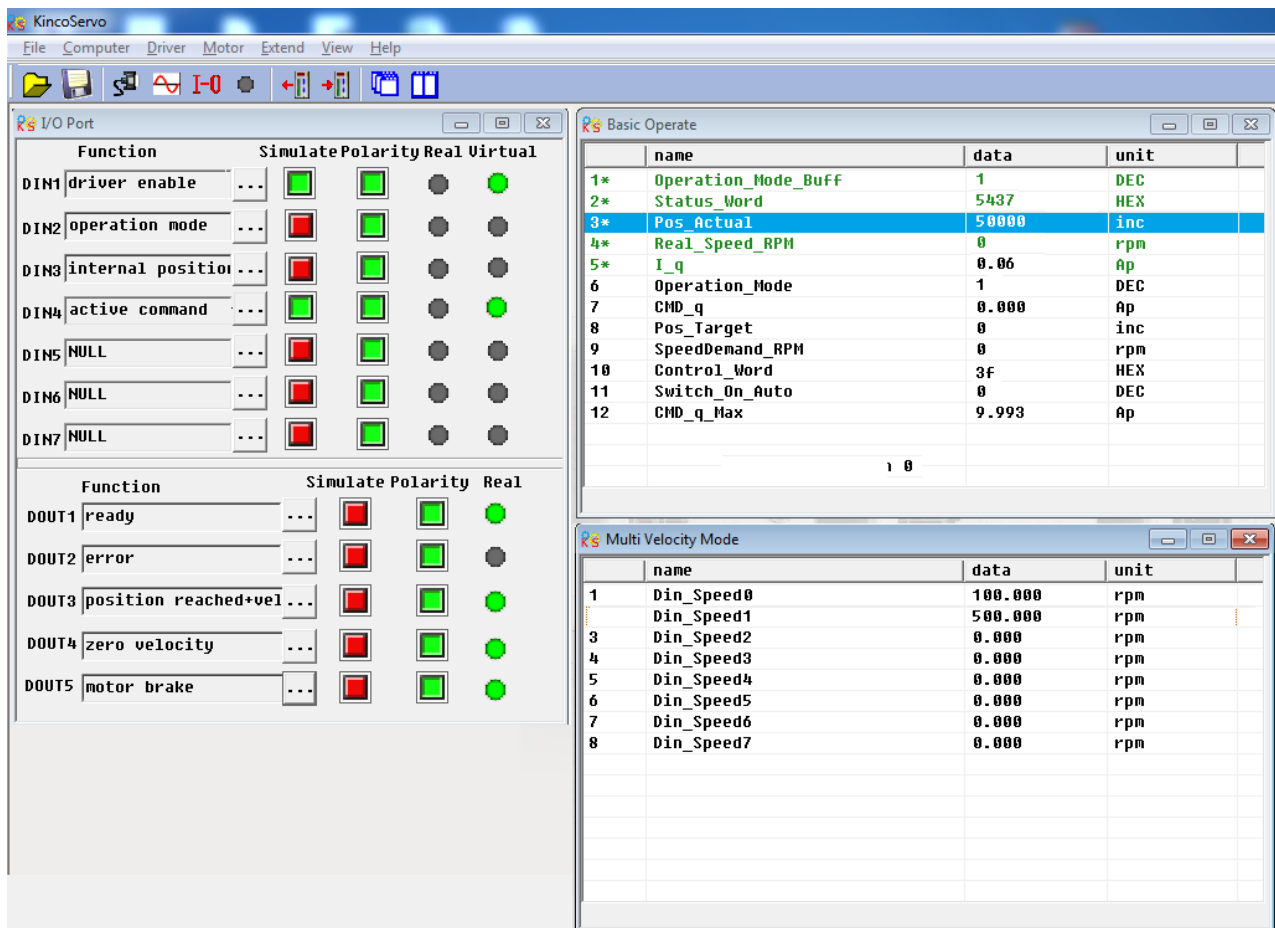
2.3 Change the functions of I/O port as following figure.



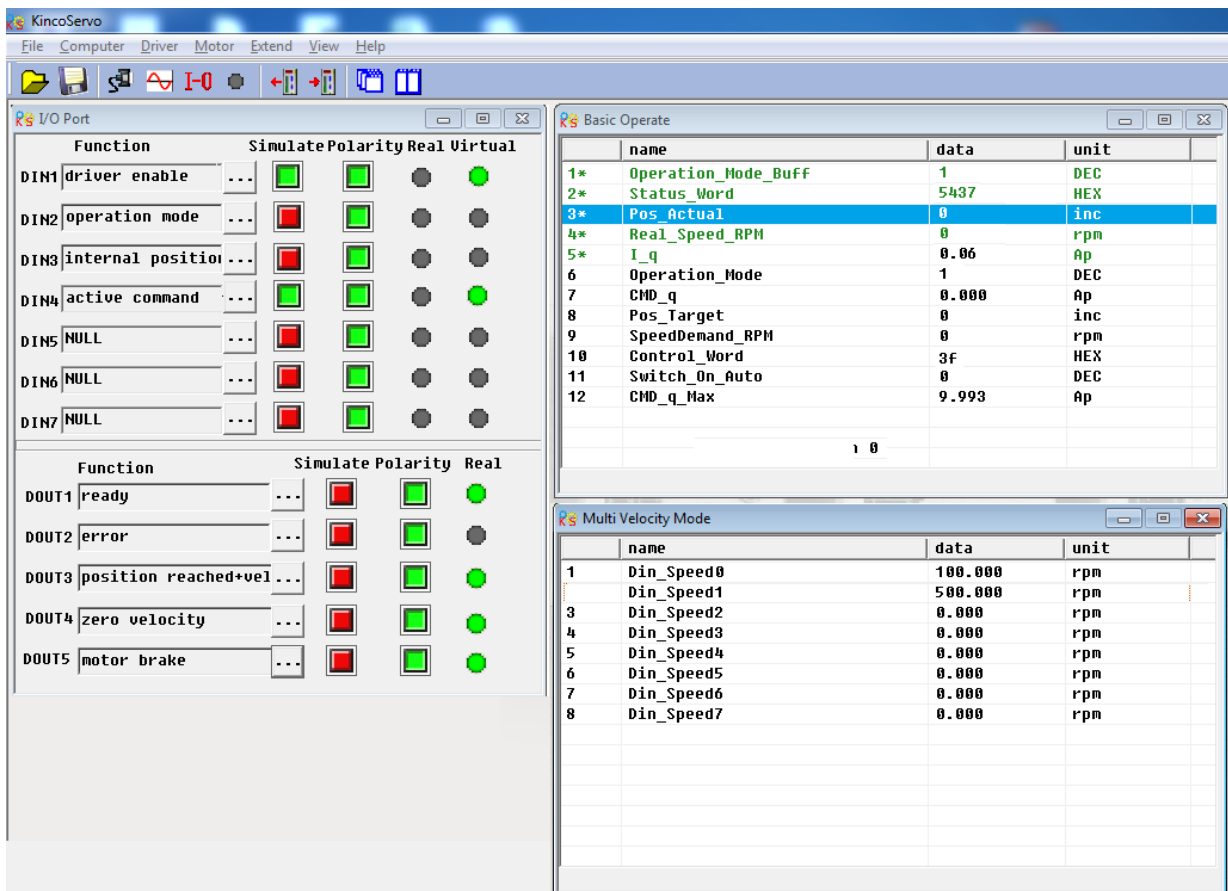
2.4 Set operation mode as following figure.

	name	data	unit
6	Din6_Function	0	HEX
7	Din7_Function	0	HEX
8	Dio_Polarity	0	Hex
9	Dio_Simulate	0	Hex
10	Switch_On_Auto	0	DEC
11	Dout1_Function	1	HEX
12	Dout2_Function	2	HEX
13	Dout3_Function	a4	HEX
14	Dout4_Function	8	HEX
15	Dout5_Function	10	HEX
16	Din_Mode0	1	DEC
17	Din_Mode1	-3	DEC
18	Din_Speed0_RPM	200	rpm
19	Din_Speed1_RPM	500	rpm
20	Din_Speed2_RPM	0	rpm

2.5 After driver enable, simulate "Activate command" as ON and observe "Real_Speed_RPM" and "Pos_Actual"



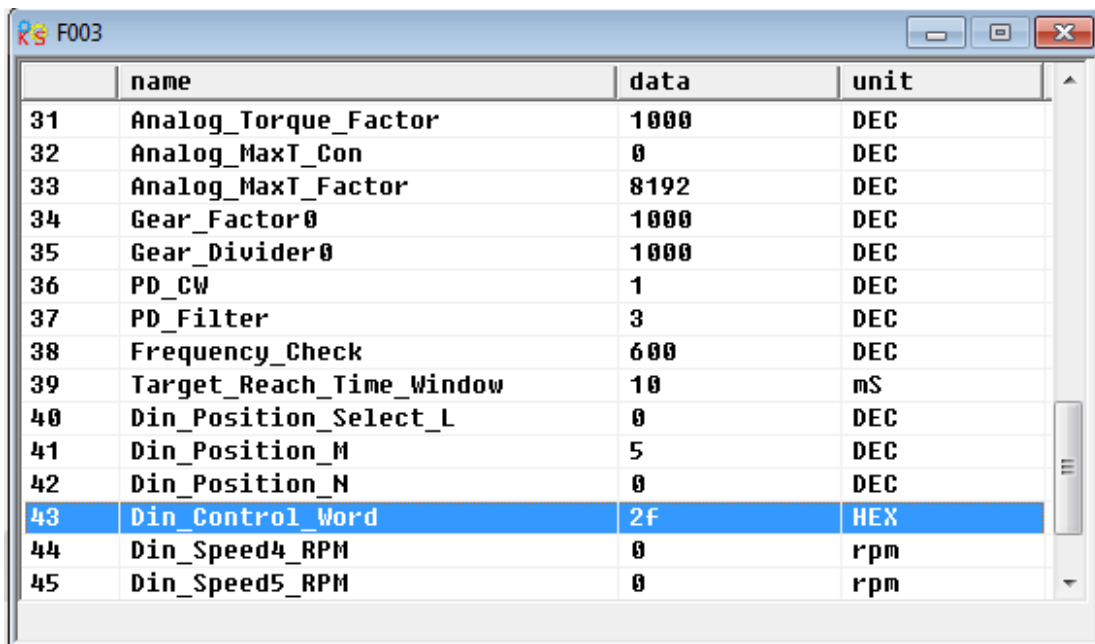
2.6 Simulate DIN3 as ON, then simulate “Activate command” as ON and observe “Pos_Actual”.



7. Save parameters.

Note: In internal position mode, there are absolute positioning and relative positioning.

Change parameter “Din_Control_Word” in “Driver->Control Panel->F003” as shown in following figure.



	name	data	unit
31	Analog_Torque_Factor	1000	DEC
32	Analog_MaxT_Con	0	DEC
33	Analog_MaxT_Factor	8192	DEC
34	Gear_Factor0	1000	DEC
35	Gear_Divider0	1000	DEC
36	PD_CW	1	DEC
37	PD_Filter	3	DEC
38	Frequency_Check	600	DEC
39	Target_Reach_Time_Window	10	mS
40	Din_Position_Select_L	0	DEC
41	Din_Position_M	5	DEC
42	Din_Position_N	0	DEC
43	Din_Control_Word	2F	HEX
44	Din_Speed4_RPM	0	rpm
45	Din_Speed5_RPM	0	rpm

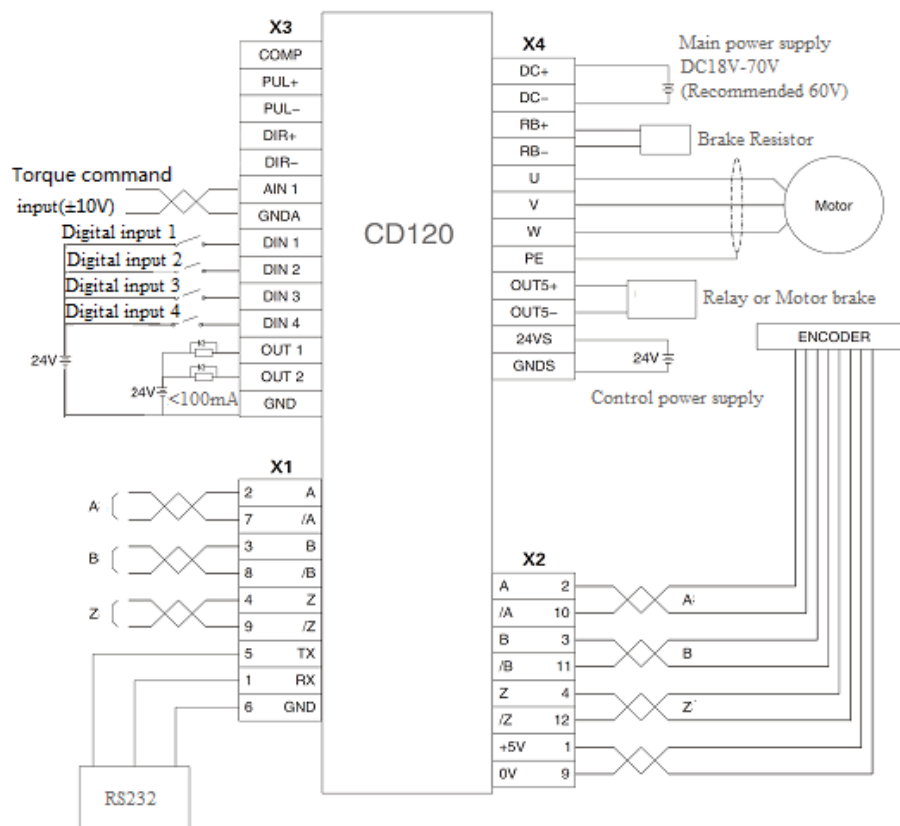
Set as F for absolute positioning.If it needs to update the command immediately,then set as 2F.

Set as 4F for relative positioning.If it needs to update the command immediately,then set as 6F.

Save parameters and reboot servo.

5.2.4 Torque Mode(Mode 4)

1.Wiring diagram



2.Parameters Descriptions

Numeric Display	Variable Name	Meaning	Default Value	Range
d3.22	Analog1_Filter	Used to smooth the input analog signals. Filter frequency: $f=4000/(2\pi \cdot \text{Analog1_Filter})$ Time Constant: $\tau = \text{Analog1_Filter}/4000$ (S)	5	1~127
d3.23	Analog1_Dead	Sets dead zone data for external analog signal 1	0	0~8192
d3.24	Analog1_Offset	Sets offset data for external analog signal 1	0	-8192~8192
d3.25	Analog2_Filter	Used to smooth the input analog signals. Filter frequency: $f=4000/(2\pi \cdot \text{Analog1_Filter})$ Time Constant (T) = $\text{Analog2_Filter}/4000$ (S)	5	1~127
d3.26	Analog2_Dead	Sets dead zone data for external analog signal 2	0	0~8192
d3.27	Analog2_Offset	Sets offset data for external analog signal 2	0	-8192~8192
d3.30	Analog_Torque_Con	Selects analog - torque channels 0: Invalid analog channel 1: Valid analog channel 1 (AIN1) 2: Valid analog channel 2 (AIN2) Valid mode 4	0	N/A
d3.31	Analog_Torque_Factor	Sets the proportion between analog signals and output torque (current)	1000	N/A
d2.15	Speed_Limit_Factor	The factor that limits the maximum speed in the torque mode $\begin{cases} F_{\text{Actual_torque}} = F_{\text{Demand_torque}} & \dots\dots\dots V_{\text{Actual_speed}} \leq V_{\text{Max_speed}} \\ F_{\text{Actual_torque}} = F_{\text{Demand_torque}} \cdot N \cdot (V_{\text{Actual_speed}} - V_{\text{Max_speed}}) & \dots\dots\dots V_{\text{Actual_speed}} > V_{\text{Max_speed}} \end{cases}$ $V_{\text{max_speed}}$ complies with d2.24 Max_Speed_RPM parameter settings.	10	0~1000
d2.24	Max_Speed_RPM	Limits the max rotation speed of the motor	5000	0~6000

In the analog – torque mode, external analog command signals are directly inputted to the current loops in the driver, thus directly controlling target current through the internal current loop. Analog signal is processed in the same way as that in the analog – speed mode.

In the analog – torque mode, I_{demand} is calculated according to the specified T_{demand} with the

formula of $T_{demand} = K_t * \frac{I_{demand}}{\sqrt{2}}$ (K_t is a torque constant).

$Factor$ is calculated according to I_{demand} and U_{filter} with the formula of

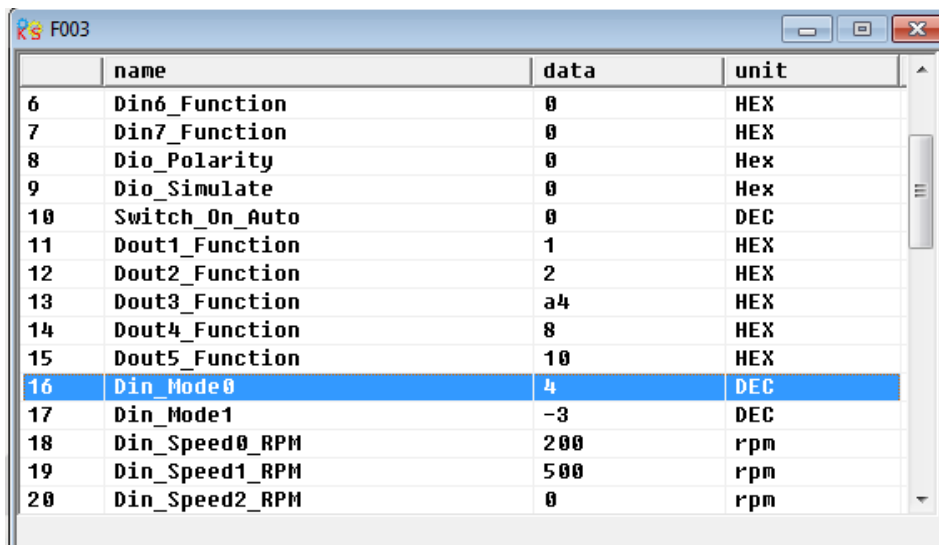
$$I_{demand} = \frac{Factor * U_{filter}}{2048 * 2048} * I_{peak} \quad (I_{peak} \text{ indicates the peak current of a driver}).$$

In summary, the calculation procedure for analog – torque mode is as following table.

Procedure	Method	Formula
Step 1	Calculate U_{filter} according to the offset voltage and dead zone voltage that require settings	$\frac{2047}{10v} = \frac{U_{filter}}{10v - U_{shift} - U_{dead}}$
Step 2	Calculate I_{demand} according to the required torque T_{demand}	$T_{demand} = K_t * \frac{I_{demand}}{\sqrt{2}}$
Step 3	Calculate $Factor$ according to U_{filter} and I_{demand}	$I_{demand} = \frac{Factor * U_{filter}}{2048 * 2048} * I_{peak}$
Step 4	Calculate $Analog_Dead$ according to the required dead zone voltage	$8191/10v = Analog_Dead / U_{dead}$
Step 5	Calculate $Analog_Offset$ according to the required offset voltage	$8191/10v = Analog_Offset / U_{shift}$

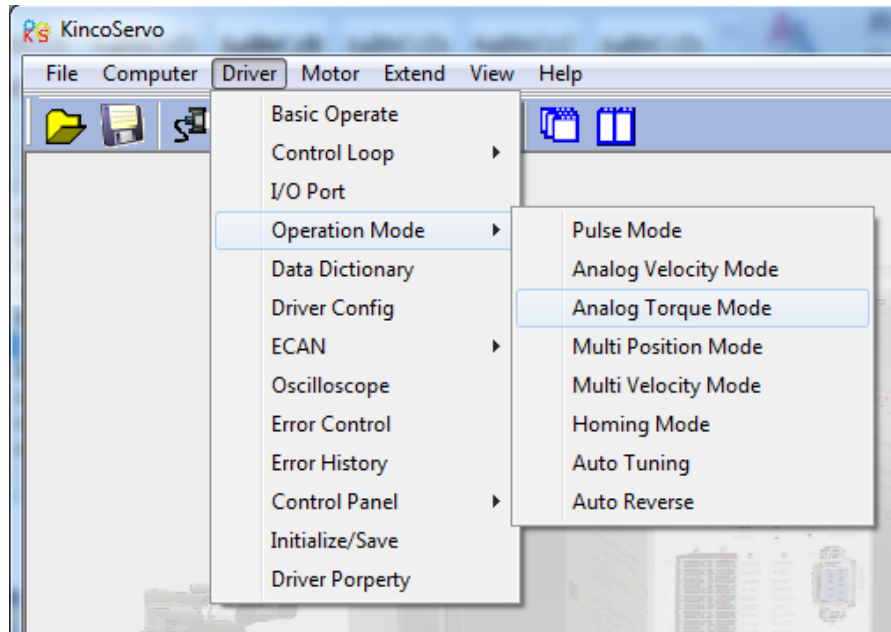
3. Operate by PC software

3.1 Set “Din_Mode0” as 4 in “Driver->Control panel->F003” as shown in following figure.



	name	data	unit
6	Din6_Function	0	HEX
7	Din7_Function	0	HEX
8	Dio_Polarity	0	Hex
9	Dio_Simulate	0	Hex
10	Switch_On_Auto	0	DEC
11	Dout1_Function	1	HEX
12	Dout2_Function	2	HEX
13	Dout3_Function	a4	HEX
14	Dout4_Function	8	HEX
15	Dout5_Function	10	HEX
16	Din_Mode0	4	DEC
17	Din_Mode1	-3	DEC
18	Din_Speed0_RPM	200	rpm
19	Din_Speed1_RPM	500	rpm
20	Din_Speed2_RPM	0	rpm

3.2 Set related parameters for analog channel 1 in Analog Torque Mode.



	name	data	unit
1*	ADC1_Buff[1]	2019	DEC
2*	Analog1_out	9.89	V
3*	ADC2_Buff[1]	0	DEC
4*	Analog2_out	0	V
5	Analog1_Filter	5	DEC
6	Analog1_Dead	0	DEC
7	Analog1_Offset	0	DEC
8	Analog2_Filter	5	DEC
9	Analog2_Dead	0	DEC
10	Analog2_Offset	0	DEC
11	Analog_Torque_Factor	1000	DEC
12	Analog_Torque_Con	1	DEC
13	Analog_MaxT_Con	0	DEC
14	Analog_MaxT_Factor	8192	DEC
15	Speed_Limit_Factor	10	DEC

3.3 Save parameters.

5.2.5 Homing Mode(Mode 6)

1. Procedure of homing

Use the following steps to homing:

1. Set the external I / O parameters, and then save.
2. Set the data for homing, and then save.
3. Execute homing

2.Parameters descriptions.

Here are simple descriptions of the data for executing homing.

0x607C0020	Home_Offset	Home offset	In Homing mode, set the offset relative to the zero point.
0x60980008	Homing_Method	Homing method	Select the homing method
0x60990120	Homing_Speed_Switch	Speed for searching the limit switch	Set the speed for searching the limit switch which defined as homing signal.
0x60990220	Homing_Speed_Zero	Speed for searching the Zero point.	Only valid when find Index signal.
0x60990308	Homing_Power_On	Homing when power on	Every time after power on,it will start homing once.
0x609A0020	Homing_AccelARATION	Homing acceleration	Control the acceleration of homing

CD120 has 27 methods for homing, referring the CANopen's definition of DSP402.

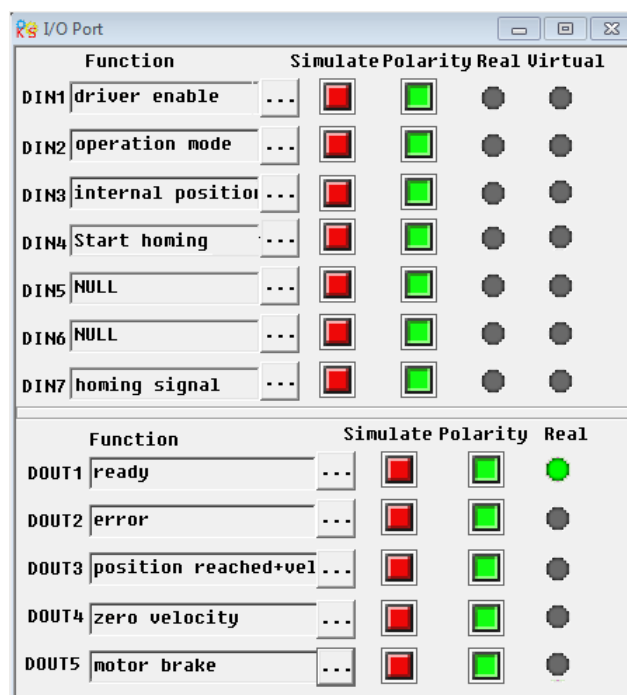
1st-14th methods use Z signal as homing signal.

17th-30th methods use external signal as homing signal.

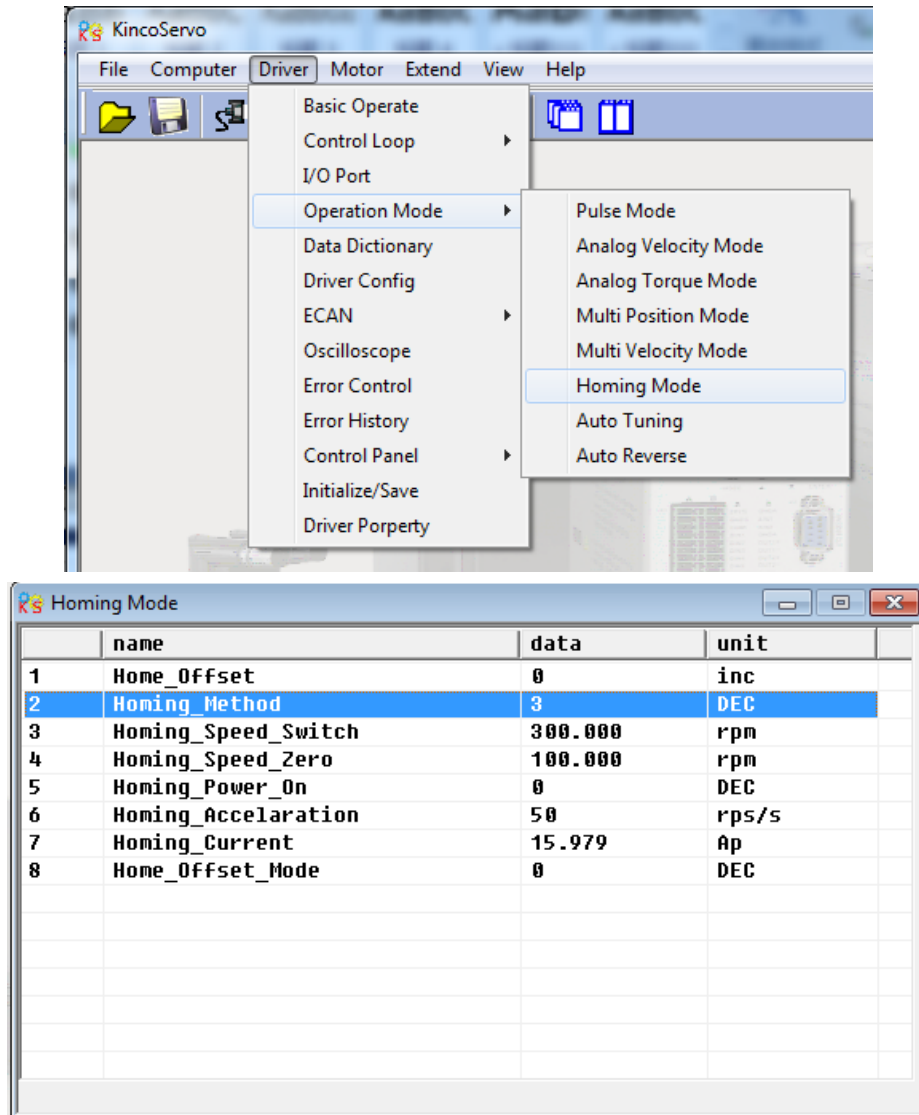
More details please refer to Appendix.

3.Operate by PC software

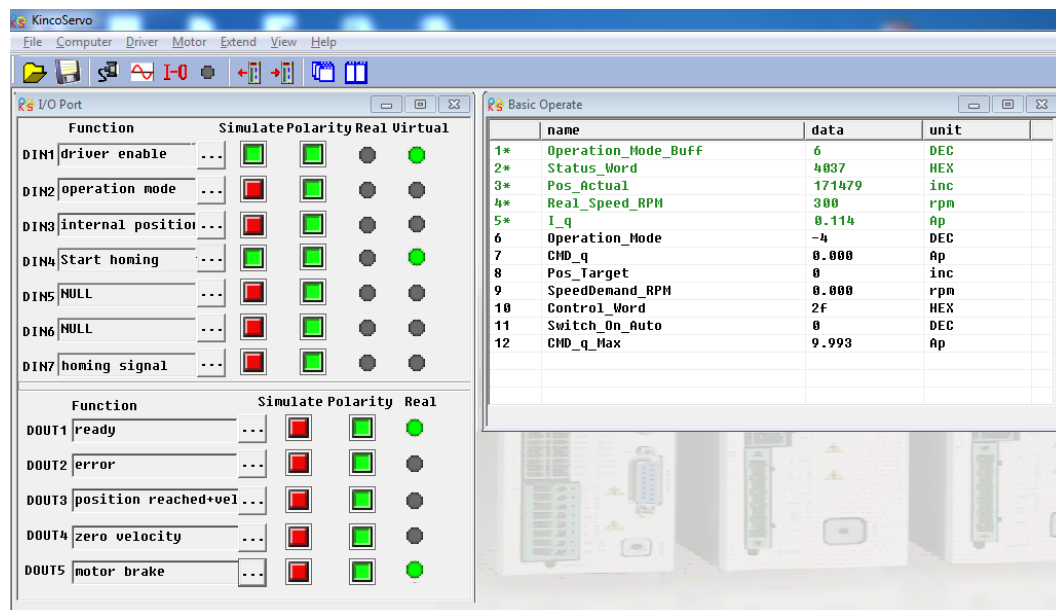
3.1 Set I/O port as following figure.



3.2 Set parameters of homing mode as following figure.



3.3 Simulate DIN4 (Start homing) as ON to start homing function.



3.4 Save parameters.

Note: "Start homing" is triggered by rising edge signal.

Chapter 6 Control Performance

6.1 Auto Reverse

In this mode, motor will run forward and reverse continuously according to the setting mode. User can set parameters in velocity loop and position loop in this mode. Please make sure auto forward/reverse is allowed in the machine before using this mode and make sure the power of driver can be cut off anytime to avoid accident.

Operation procedure for auto reverse:

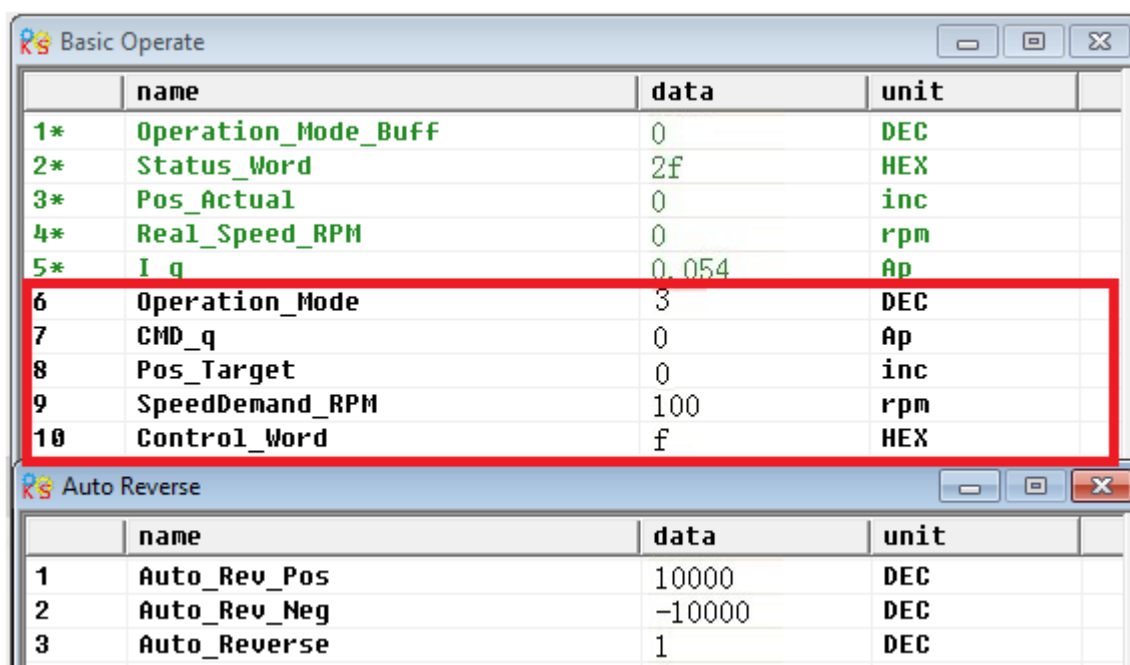
- 1: Use JD-PC software to online according to chapter 5.
- 2: Set speed mode control according to 5.4.1.
- 3: Click the menu "Driver-Operation mode-Auto Reverse" and set the parameter for auto reverse.

Set "Auto_Reverse" as 0 for no control.

Set "Auto_Reverse" as 1 for position control. The motor will run between the position "Auto_Rev_Pos" and "Auto_Rev_Neg". The unit is inc. The speed depends on target velocity.

Set "Auto_Reverse" as 3 for time control. The motor will run between time "Auto_Rev_Pos" and "Auto_Rev_Neg". The unit is ms. The speed depends on target velocity.

Following figure shows the parameters need to set. In this figure, the servo will run between -10000 inc and 10000 at speed 100RPM.



The image shows two windows from the JD-PC software. The top window, titled 'Basic Operate', contains a table of parameters. A red rectangle highlights rows 6 through 10. The bottom window, titled 'Auto Reverse', contains a table with three rows of parameters.

	name	data	unit
1*	Operation_Mode_Buff	0	DEC
2*	Status_Word	2f	HEX
3*	Pos_Actual	0	inc
4*	Real_Speed_RPM	0	rpm
5*	I q	0.054	Ap
6	Operation_Mode	3	DEC
7	CMD_q	0	Ap
8	Pos_Target	0	inc
9	SpeedDemand_RPM	100	rpm
10	Control_Word	f	HEX

	name	data	unit
1	Auto_Rev_Pos	10000	DEC
2	Auto_Rev_Neg	-10000	DEC
3	Auto_Reverse	1	DEC

6.2 Driver Performance Tuning

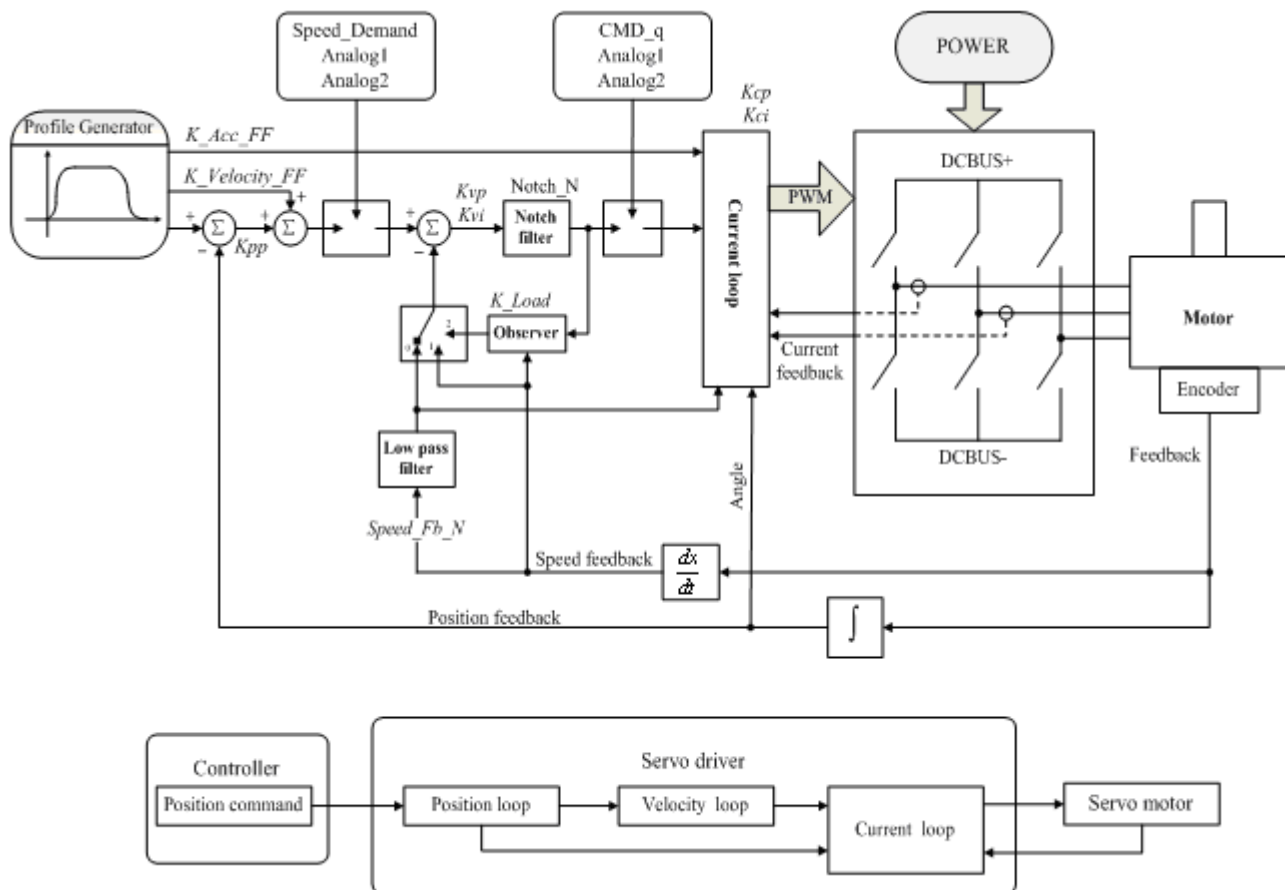


Fig. 6-1 Schematic diagram for control loop adjustment

As shown in Fig. 6-1, a typical servo system contains three control loops, namely, position loop, velocity loop, and current loop.

Current loop are related to motor parameters (optimal parameters of the selected motor are default for the driver and no adjusting is required).

Parameters for velocity loop and position loop should be adjusted properly according to load conditions.

During adjustment of the control loop, ensure that the bandwidth of the velocity loop is at least twice of that of

the position loop; otherwise oscillation may occur.

6.2.1 Manual Adjustment

1. Parameters for velocity loop

Table 6-1 Parameters for velocity loop

Numeric Display	Variable Name	Meaning	Default Value	Range
d2.01	Kvp	Sets the response speed of a velocity loop	100	0~32767
d2.02	Kvi	Adjusts speed control so that the time of minor errors is compensated	2	0~16384
d2.05	Speed_Fb_N	Reduces the noise during motor operation by	45	0~45

		reducing the feedback bandwidth of velocity loops (smoothing feedback signals of encoders). When the set bandwidth becomes smaller, the motor responds slower. The formula is $F = \text{Speed_Fb_N} * 20 + 100$. For example, to set the filter bandwidth to "F = 500 Hz", you need to set the parameter to 20.		
--	--	---	--	--

Proportional gain of velocity loop Kvp: If the proportional gain of the velocity loop increases, the responsive bandwidth of the velocity loop also increases. The bandwidth of the velocity loop is directly proportional to the speed of response. Motor noise also increases when the velocity loop gain increases. If the gain is too great, system oscillation may occur.

Integral gain of velocity loop Kvi: If the integral gain of the velocity loop increases, the low-frequency intensity is improved, and the time for steady state adjustment is reduced; however, if the integral gain is too great, system oscillation may occur.

Adjustment steps:

Step 1: Adjust the gain of velocity loop to calculate the bandwidth of velocity loop

Convert the load inertia of the motor into the inertia JI of the motor shaft, and then add the inertia Jr of the motor itself to obtain $J_t = J_r + J_I$. Put the result into the formula:

$$Vc_Loop_BW = Kvp * \frac{I_p * K_t * Encoder_R}{J_t * 204800000 * \sqrt{2} * 2\pi}$$

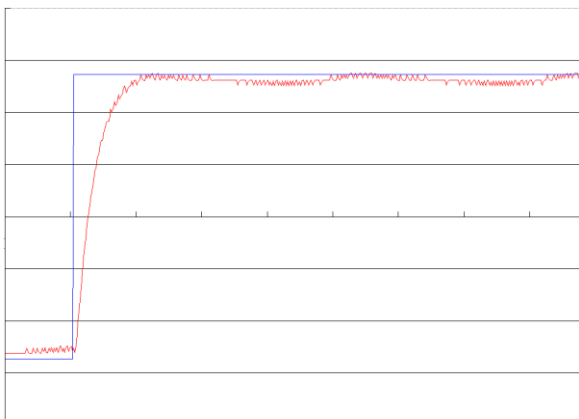
To calculate the bandwidth of the velocity loop

Vc_Loop_BW according to the adjusted the gain of velocity loop Kvp, only adjust Kvi according to actual requirements.

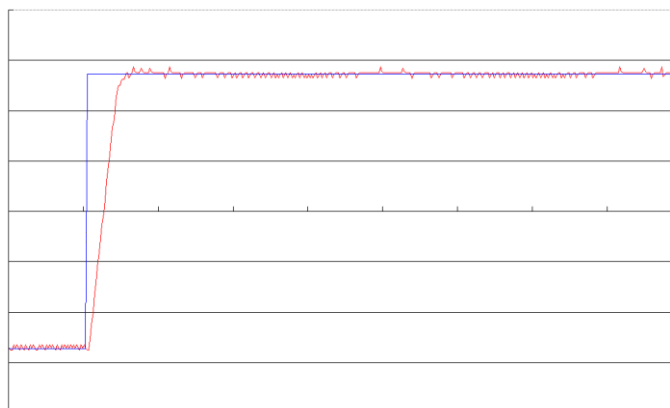
Adjust the impact of Kvp and Kvi, as shown in Fig.6-2.

For the effect of Kvp adjustment, see the first to the fourth from left of Fig. 6-2. Kvp gradually increases from the first to the fourth from left. The value of Kvi is 0.

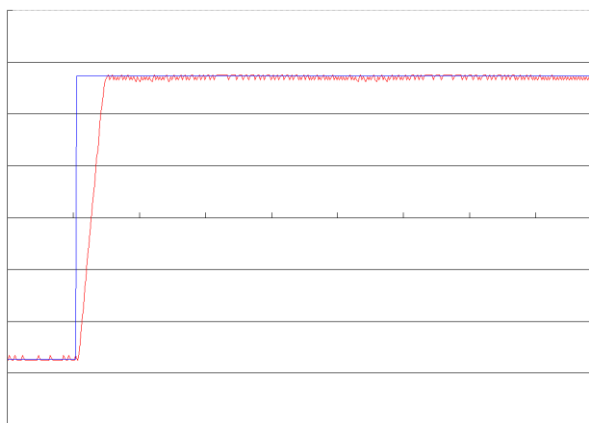
For the effect of Kvi adjustment, see the first to the fourth from right of Fig. 6-2. Kvi gradually increases from the first to the fourth from right. The value of Kvp remains unchanged.



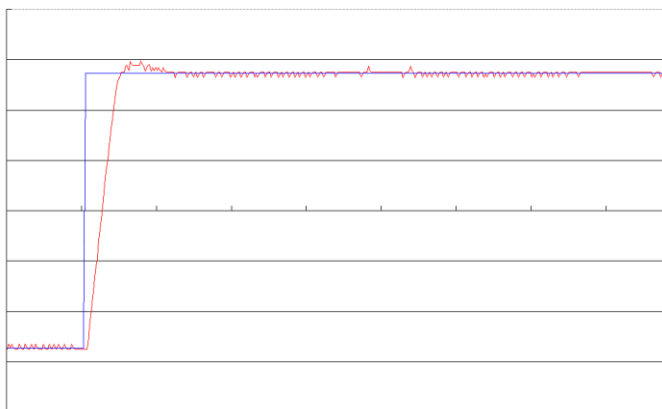
Left 1



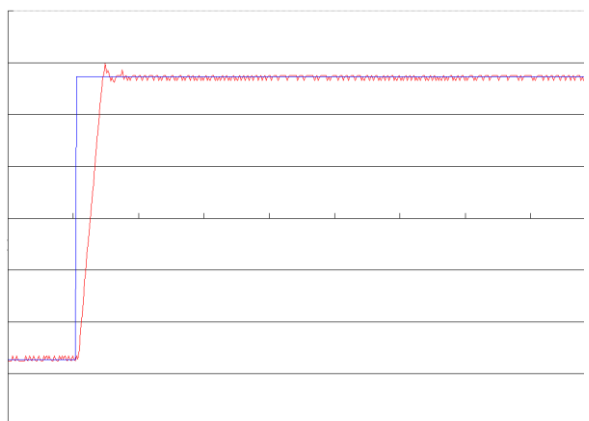
Right 1



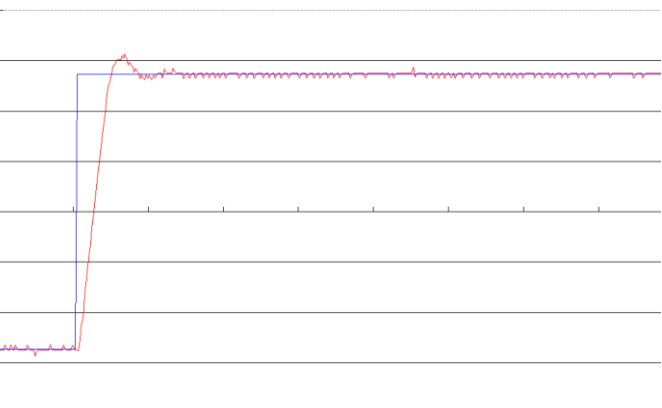
Left 2



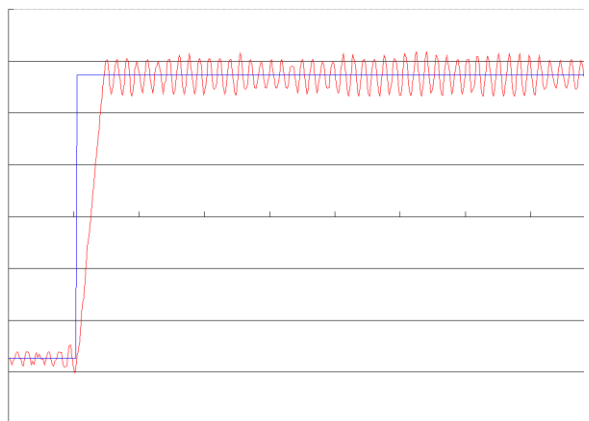
Right 2



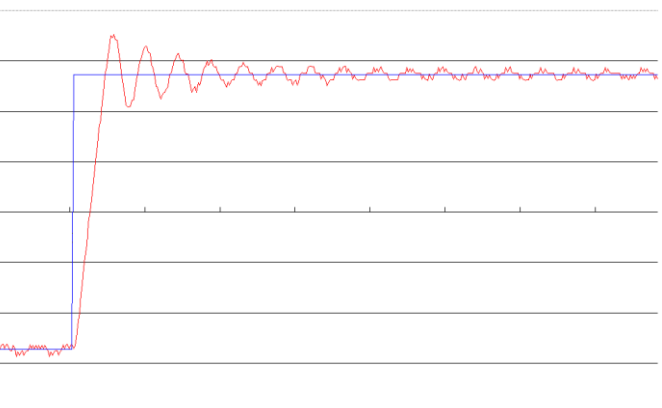
Left 3



Right 3



Left 4



Right 4

Fig.6-2 Schematic diagram of gain adjustment of velocity loop

Step 2: Adjust parameters for feedback filter of velocity loop

During gain adjustment of a velocity loop, if the motor noise is too great, you can properly reduce the parameter Speed_Fb_N for feedback filter of the velocity loop; however, the bandwidth F of the feedback filter of velocity loop must be at least three times of the bandwidth of velocity loop; otherwise oscillation may occur. The formula for calculating the bandwidth of feedback filter of velocity loop is $F = \text{Speed_Fb_N} \times 20 + 100$ (Hz).

2. Parameters for position loop

Table 6-2 Parameters for position loop

Variable Name	Meaning	Default Value	Range
Kpp	Indicates the proportional gain of the position loop Kpp	1000	0~16384
K_Velocity_FF	0 indicates no feedforward, and 256 indicates 100% feedforward	256	0~256
K_Acc_FF	The value is inversely proportional to the feedforward	7FF.F	32767~10
Pc_Loop_BW	Sets the bandwidth of the position loops in Hz	0	N/A
Pos_Filter_N	Set the average filter	1	1~255

Proportional gain of the position loop Kpp: If the proportional gain of the position loop increases, the bandwidth of the position loop is improved, thus reducing both the positioning time and following errors. However, too great bandwidth may cause noise or even oscillation. Therefore, this parameter must be set properly according to loading conditions. In the formula $Kpp = 103 * Pc_Loop_BW$, Pc_Loop_BW indicates the bandwidth of the position loop. The bandwidth of a position loop is less than or equal to that of a velocity loop. It is recommended that Pc_Loop_BW be less than $Vc_Loop_BW / 4$ (Vc_Loop_BW indicates the bandwidth of a velocity loop).

Velocity feedforward of the position loop K_Velocity_FF: the velocity feedforward of a position loop can be increased to reduce position following errors. When position signals are not smooth, if the velocity feedforward of a position loop is reduced, motor oscillation during running can be reduced.

Acceleration feedback of the position loop K_Acc_FF (adjustment is not recommended for this parameter): If great gains of position rings are required, the acceleration feedback K_Acc_FF can be properly adjusted

to improve performance. $K_Acc_FF = \frac{I_p * K_t * Encoder_R}{250000 * \sqrt{2} * J_t * \pi}$ Note: K_Acc_FF is inversely proportional

to the acceleration feedforward.

Pos_Filter_N is used for average filter of the speed produced by target position. Setting this parameter as N means to average N data.

Adjustment procedure:

Step 1: Adjust the proportional gain of a position loop.

After adjusting the bandwidth of the velocity loop, it is recommended to adjust Kpp according to actual requirements (or directly fill in the required bandwidth in Pc_Loop_BW , and the driver will automatically calculate the corresponding Kpp). In the formula $Kpp = 103 * Pc_Loop_BW$, the bandwidth of the position loop is less than or equal to that of the velocity loop. For a common system, Pc_Loop_BW is less than $Vc_Loop_BW / 2$; for the CNC system, it is recommended that Pc_Loop_BW is less than $Vc_Loop_BW / 4$.

Step 2: Adjust velocity feedforward parameters of the position loop.

Velocity feedforward parameters (such as K_Velocity_FF) of the position loop are adjusted according to position errors and coupling intensities accepted by the machine. The number 0 represents 0% feedforward, and 256 represents 100% feedforward.

3. Parameters for pulse filtering coefficient

Table 6-3 Parameters for pulse filtering coefficient

Variable Name	Meaning	Default Value	Range
PD_Filter	Used to smooth the input pulses. Filter frequency: $f = 1000/(2\pi * PD_Filter)$ Time constant: $T = PD_Filter/1000$ Unit: S Note: If you adjust this filter parameter during the operation, some pulses may be lost.	3	1~32767

When a driver operates in the pulse control mode, if the electronic gear ratio is set too high, this parameter must be adjusted to reduce motor oscillation; however, if the parameter adjustment is too great, motor running instructions will become slower.

6.2.2 Auto Adjustment (Only for Velocity Loops)

Auto adjustment is only available for velocity loops (see Section 6.21 for manual adjustment of position loops) when both forward rotation and reverse rotation of a motor are allowable, and the loadings do not change much during the operation. You can determine the total inertia of motor loadings through gain auto tuning, and then manually enter the desired bandwidth. The driver will automatically calculate appropriate Kvp and Kvi values. The motion curve is in the shape of a sine curve, as shown in Fig. 6-3.

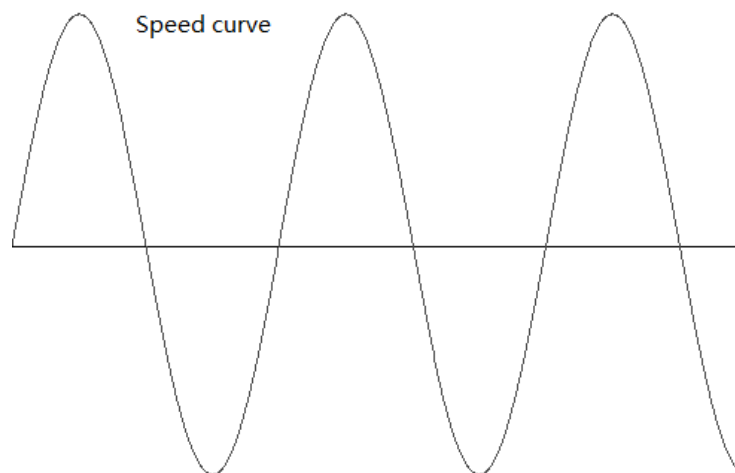


Fig.6-3 Speed curve

K_Load represents the internal data that displays the actual inertia of the system.

$$K_Load = \frac{I_p * K_t * Encoder_R}{62500 * \sqrt{2} * \pi * J_t}$$

In the above formula:

I_p represents the maximum peak output current in units of "A";

K_t represents the torque constant of the motor in units of "Nm/Arms";

Encoder_R represents the resolution of a motor encoder in units of "inc/r";

J_t represents the total inertia of the motor and loadings in units of "kg*m^2".

Table 6-4 Parameters for controlling gain auto tuning

Variable Name	Meaning	Default Value	Range
Tuning_Start	Auto tuning starts after the variable is set to 11. All input signals are ignored during auto tuning. The variable is automatically changed to 0 after auto tuning is completed. Sets the variable to other values to end auto tuning.	0	/
Vc_Loop_BW	Sets the bandwidth of the velocity loop in Hz. The variable can only be set after auto tuning is performed properly; otherwise the actual bandwidth goes wrong, which causes abnormal working of the driver. If the auto tuning result is abnormal, setting this parameter may also cause abnormal working of the driver. Note: This parameter cannot be applied when auto tuning is unavailable.	0	0~600
K_Load	Indicates loading parameters	/	20~1500 0
Sine_Amplitude	Proper increase in this data will reduce the tuning error, but machine vibration will become severer. This data can be adjusted properly according to actual conditions of machines. If the data is too small, the auto tuning error becomes greater, or even causes a mistake	64	0~1000
Tuning_Scale	It is helpful to reduce the auto tuning time by reducing the data, but the result may be unstable.	128	0~16384
Tuning_Filter	Indicates filter parameters during auto-tuning	64	1~1000

Auto tuning is a process where the suitable and stable K_Load value is automatically calculated. In the auto tuning mode, the data of numeric display is automatically switched to the real-time display mode of K_Load data. When K_Load data gradually becomes stable, the driver automatically adjusts Kvp and Kvi data of a velocity loop, so that the actual bandwidth of the velocity loop is 50Hz. When K_Load data becomes stable, the driver automatically stops auto tuning operation; then you need to customize Vc_Loop_BW, representing the desired bandwidth of the velocity ring. Finally, run the test system in the actual environment, and save the parameters.

Precautions:

Auto tuning applies when both forward rotation and reverse rotation of a motor are allowable, and the loadings do not change much during the operation. When forward rotation or reverse rotation of the motor

is not allowable on a device, it is recommended to adjust the parameters manually.

During auto tuning operation, pulse signals, digital input signals, and analog signals of the external controller are temporarily unavailable, so safety must be ensured.

Before auto tuning operation, it is recommended to properly adjust the Kvp, Kvi and Speed_Fb_N (a feedback filter parameter) values of the velocity loop to prevent visible oscillations when the system works in the speed mode. If necessary, adjust the data of notch filter to inhibit resonance.

The time for different load tuning varies, and generally a few seconds is required. The auto tuning time can be reduced by presetting the K_Load value to a predicted value that is close to the actual value.

Vc_Loop_BW can be written only after successful auto tuning, otherwise the driver may work improperly. After you write the desired bandwidth of the velocity loop in Vc_Loop_BW, the driver automatically calculates the corresponding values of Kvp, Kvi and Speed_Fb_N. If you are dissatisfied with low-speed smoothness, you can manually adjust Kvi. Note that auto tuning does not automatically adjust the data of a notch filter.

In the following circumstances, auto tuning parameters should be adjusted:

1. When the friction in a rotation circle of the motor is uneven, it is required to increase Sine_Amplitude to reduce the impacts caused by uneven friction. Note: it will increase the oscillation amplitude of the loadings when increase Sine_Amplitude.
2. If auto tuning lasts for a long time, initial evaluation of the total inertia is available. It is recommended to set K_Load to an evaluation value before auto tuning.
3. If auto tuning is unstable, the stability of auto tuning increases when Tuning_Scae increases properly, but the time for auto tuning slightly increases.

In the following conditions, auto adjustment goes wrong. In this case, you can only set parameters manually:

1. The load inertia is featured by great fluctuation.
2. Mechanical connection rigidity is low.
3. Clearances exist in the connection between mechanical elements.
4. The load inertia is too great, while Kvp values are set too low.
5. If the load inertia is too great, K_Load data will be less than 20; if the load inertia is too little, K_Load data will be greater than 15000.

6.3 Oscillation Inhibition

If resonance occurs during machine operation, you can adjust a notch filter to inhibit resonance. If resonance frequency is known, you can directly set Notch_N to $(BW-100)/10$. Note that you need to set Notch_On to 1 to enable the notch filter. If you do not know exactly the resonance frequency, you can firstly set the max value of current instruction to a low one, so that the oscillation amplitude is within the acceptable range; then try to adjust Notch_N to check whether resonance disappears.

If machine resonance occurs, you can calculate the resonance frequency by observing the waveform of the target current with the oscilloscope function of the driver.

Table 6-5 Parameters for oscillation inhibition

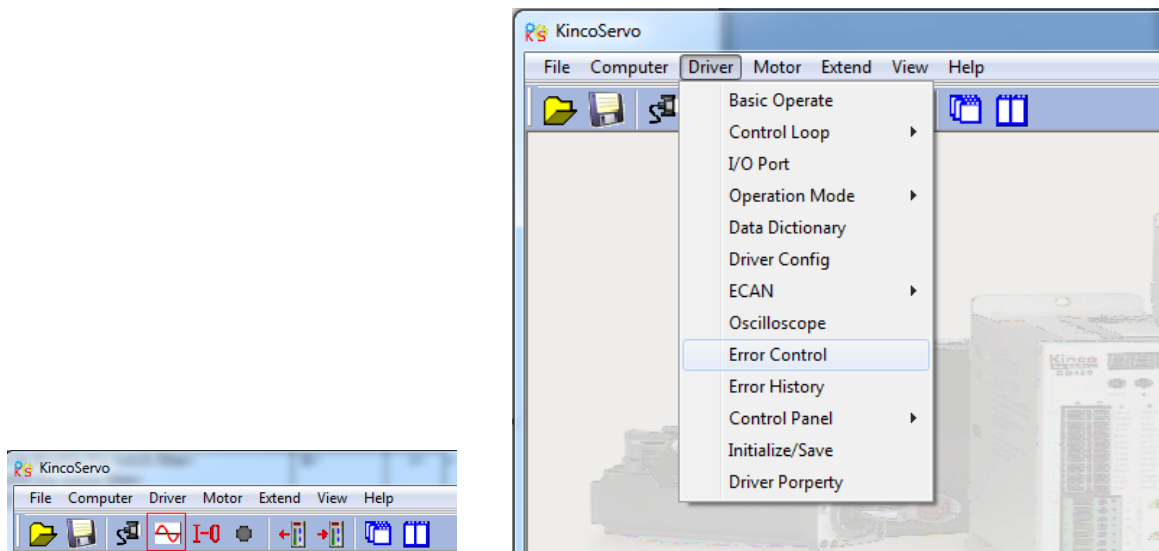
Variable Name	Meaning	Default Value	Range
Notch_N	Notch/filtering frequency setting for a velocity loop, used to set the frequency of the internal notch filter, so as to eliminate the mechanical	45	0~90

	<p>resonance produced when the motor drives the machine. The formula is $F = \text{Notch_N} \times 10 + 100$.</p> <p>For example, if the mechanical resonance frequency is $F = 500 \text{ Hz}$, the parameter should be set to 40.</p>		
Notch_On	<p>Enable or disable the notch filter</p> <p>0: Disable the notch filter</p> <p>1: Enable the notch filter</p>	0	/

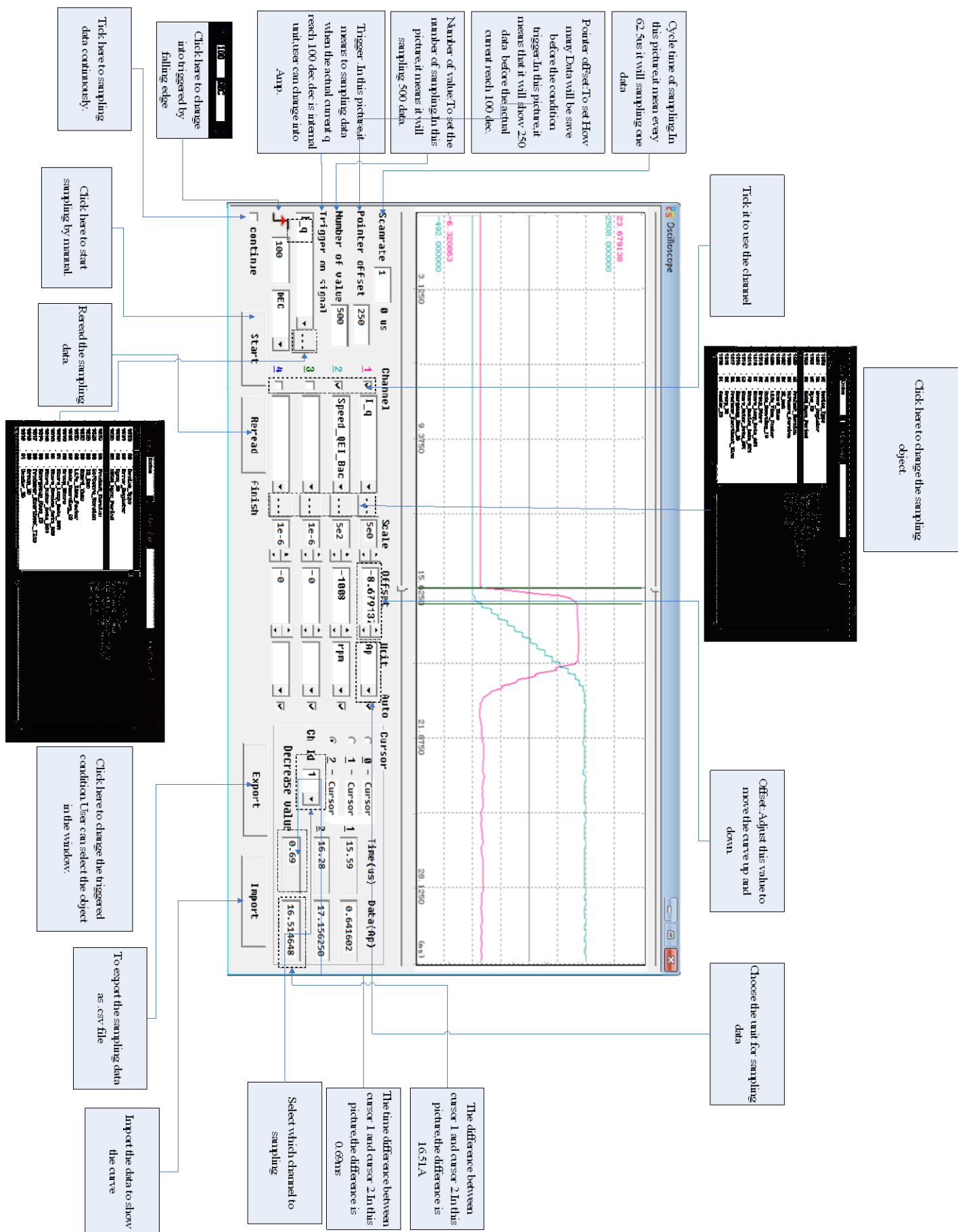
6.4 Debugging Example

6.4.1 Oscilloscope

1. Enter oscilloscope



2.Parameters for Oscilloscope



6.4.2 Procedure for Parameter Adjustment

1、Velocity Loop Adjustment

(1) Adjust Kvp according to the load.

① Set motor running at Auto Reverse mode by position(Operation mode -3),then open oscilloscope and set the parameters to observe the curve.As shown in following figures.

② Adjust Kvp and observe the speed curve.Following figures show the different curve in different Kvp.According to the curve,it shows that the bigger value of Kvp,the faster response of speed.

(2) Adjust Kvi according to load.

(3) Adjust Speed_Fb_N to reduce system noise.

Speed_Fb_N:This parameter is used to reduce system noise.But the bigger value of this parameter,the slower response of system.

In Auto Reverse mode,Kvp=40

The screenshot displays the KincoServo software interface. On the left, the 'I/O Port' window shows digital input (DIN) and output (DOUT) configurations. The 'Auto Reverse' window is open, showing a table of parameters. The 'Velocity Loop' window is also open, showing a table of parameters. The 'Basic Operate' window is visible at the bottom right, showing a list of system variables.

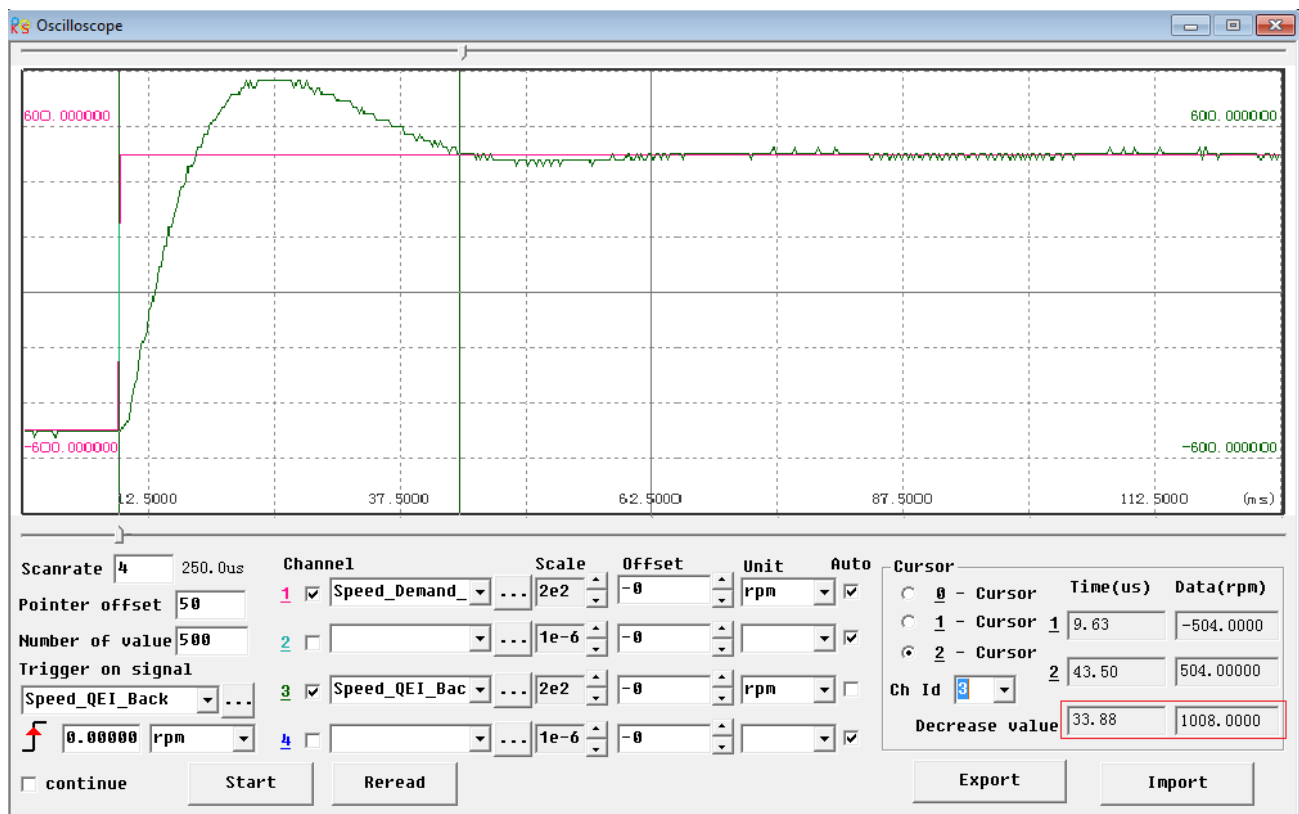
name	data	unit
1	Auto_Rev_Pos	50000 DEC
2	Auto_Rev_Neg	-50000 DEC
3	Auto Reverse	1 DEC

name	data	unit
1	Kpp	10.00 Hz
2	K_Velocity_FF	100.00 %
3	K_Acc_FF	32767 DEC
4	Pos_Filter_N	1 DEC
5	Max Following Error	10000 inc

name	data	unit
1	Kvp	40 DEC
2	Kvi	1 DEC
3	Notch_N	550.00 Hz
4	Notch_On	0 DEC
5	Speed_Fb_N	240.000 Hz

name	data	unit
1*	Operation_Mode_Buff	-3 DEC
2*	Status_Word	4037 HEX
3*	Pos_Actual	28907 inc
4*	Real_Speed_RPM	500 rpm
5*	I_q	11 Ap
6	Operation_Mode	-3 DEC
7	CMD_q	0.000 Ap
8	Pos_Target	0 inc
9	SpeedDemand_RPM	500 rpm
10	Control_Word	2f HEX
11	Switch_On_Auto	0 DEC
12	CMD_q_Max	16.691 Ap

The oscilloscope is shown as follows:actual speed response is 33.88ms



In Auto Reverse mode, Kvp=110

I/O Port

Function	Simulate	Polarity	Real	Virtual
DIN1 driver enable	...	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DIN2 fault reset	...	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DIN3 operation mode	...	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DIN4 P control	...	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DIN5 NULL	...	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DIN6 NULL	...	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DIN7 homing signal	...	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DIN8 NULL	...	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Function	Simulate	Polarity	Real
DOUT1 ready	...	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DOUT2 NULL	...	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DOUT3 position reached+vel...	...	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DOUT4 zero velocity	...	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DOUT5 NULL	...	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DOUT6 NULL	...	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DOUT7 motor brake	...	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Auto Reverse

name	data	unit
1 Auto_Rev_Pos	50000	DEC
2 Auto_Rev_Neg	-50000	DEC
3 Auto_Reverse	1	DEC

Position Loop

name	data	unit
1 Kpp	10.00	Hz
2 K_Velocity_FF	100.00	%
3 K_Acc_FF	32767	DEC
4 Pos_Filter_N	1	DEC
5 Max_Following_Error	10000	inc

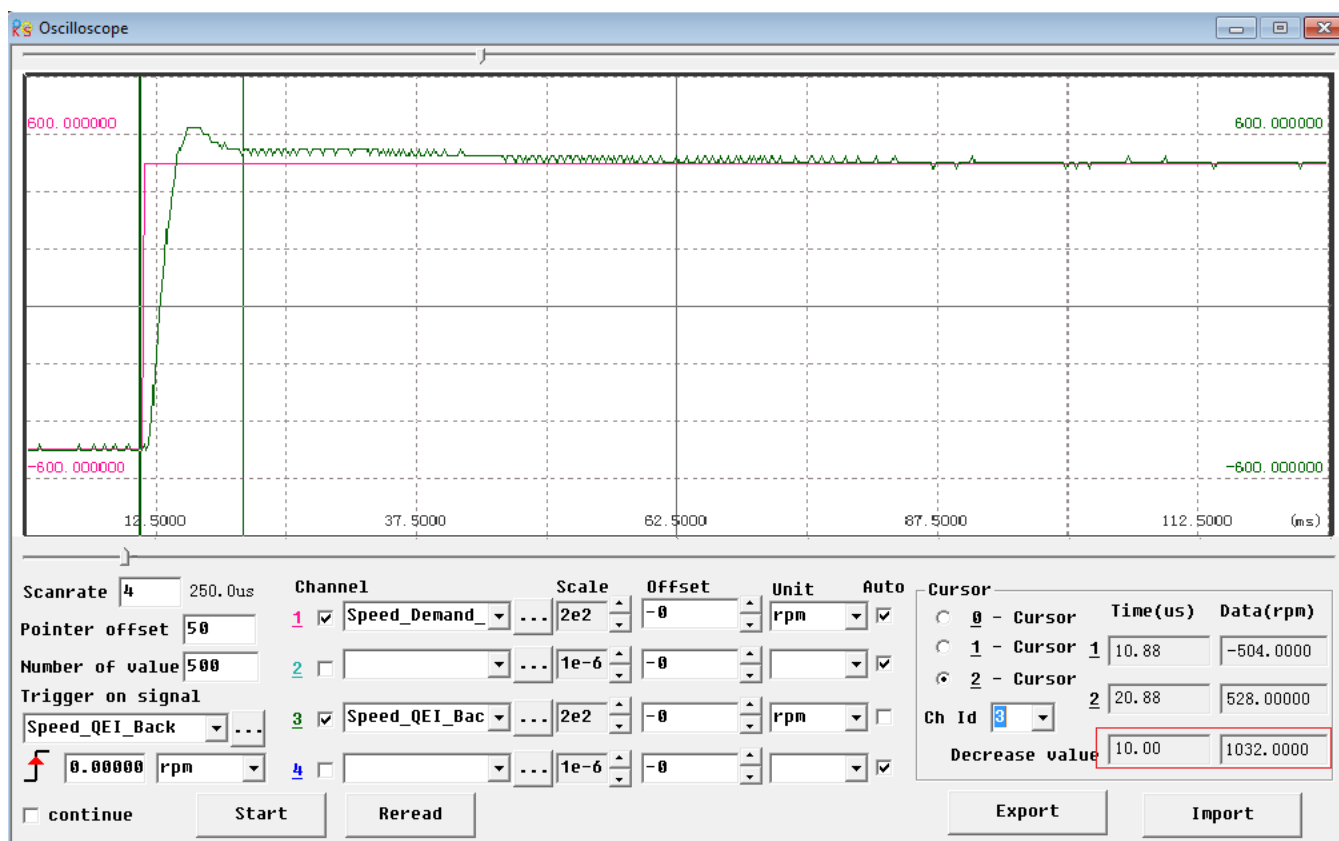
Velocity Loop

name	data	unit
1 Kvp	110	DEC
2 Kvi	1	DEC
3 Notch_N	550.00	Hz
4 Notch_On	0	DEC
5 Speed_Fb_N	240.000	Hz

Basic Operate

name	data	unit
1* Operation_Mode_Buff	-3	DEC
2* Status_Word	4437	HEX
3* Pos_Actual	4510	inc
4* Real_Speed_RPM	500	rpm
5* I_q	4	Ap
6 Operation_Mode	-3	DEC
7 CMD_q	0.000	Ap
8 Pos_Target	0	inc
9 SpeedDemand_RPM	500	rpm
10 Control_Word	2F	HEX
11 Switch_On_Auto	0	DEC
12 CMD_q_Max	16.691	Ap

The oscilloscope is shown as follows: actual speed response is 10.00ms



2. Position Loop Adjustment

(1) Adjust Kpp.

(2) Adjust Vff (K_Velocity_FF)

Adjust Vff parameter according to the allowable position error and coupling performance of machine. Normally Vff is 100%. If system doesn't need high response for position, then this parameter can be decreased to reduce overshoot.

(3) Use oscilloscope to observe curve.

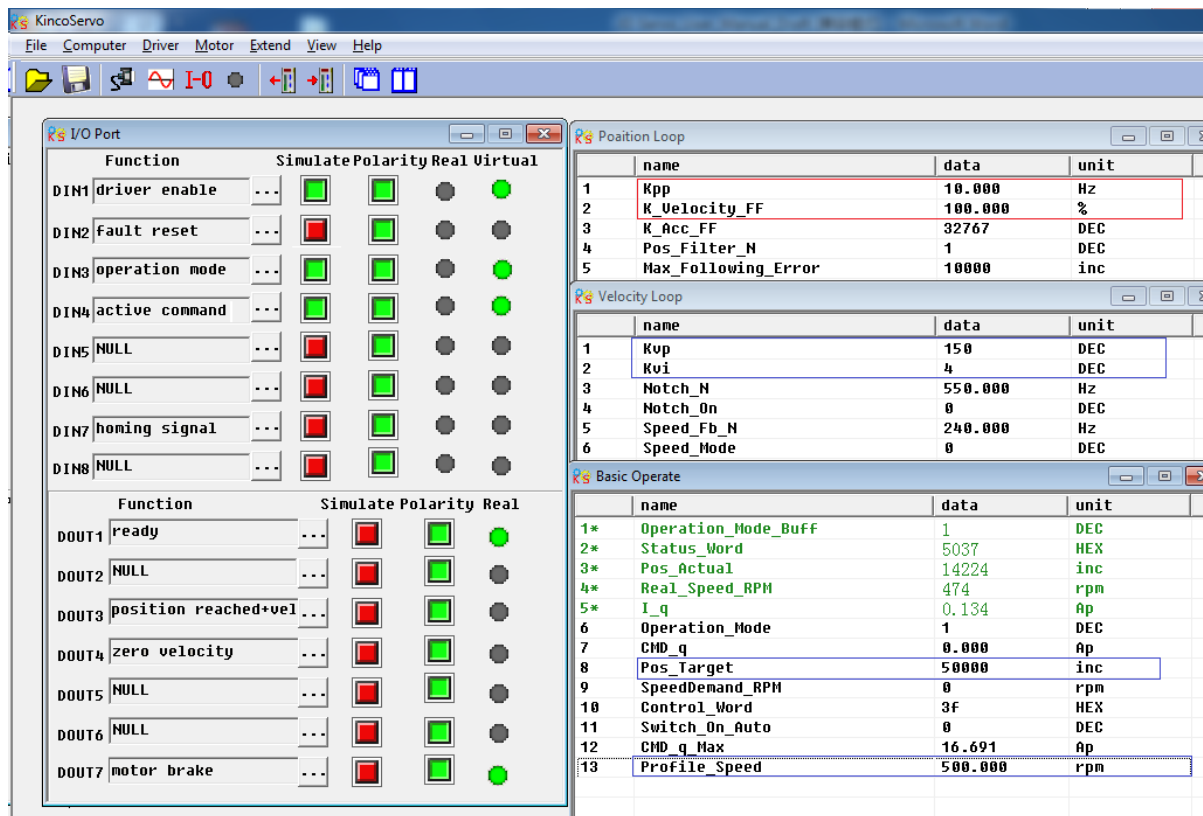
Set motor running at Auto Reverse mode by time (Operation mode 3), set parameters of oscilloscope as following figure.

In Fig.(1) and Fig.(2), Vff is 100%, When Kpp is 30, the response of position loop is faster than the one when Kpp is 10. Meanwhile the following error is also less, but overshoot is bigger.

Fig.(3), Kpp is 30, Vff is 50%. Compare with Fig.(2), the following error is bigger, but response becomes slower and there is almost no overshoot.

Internal position mode, target position is 50000 inc.

Fig.(1) Kpp=10, Vff=100%



The oscilloscope is as following: max. following error is 69 inc.

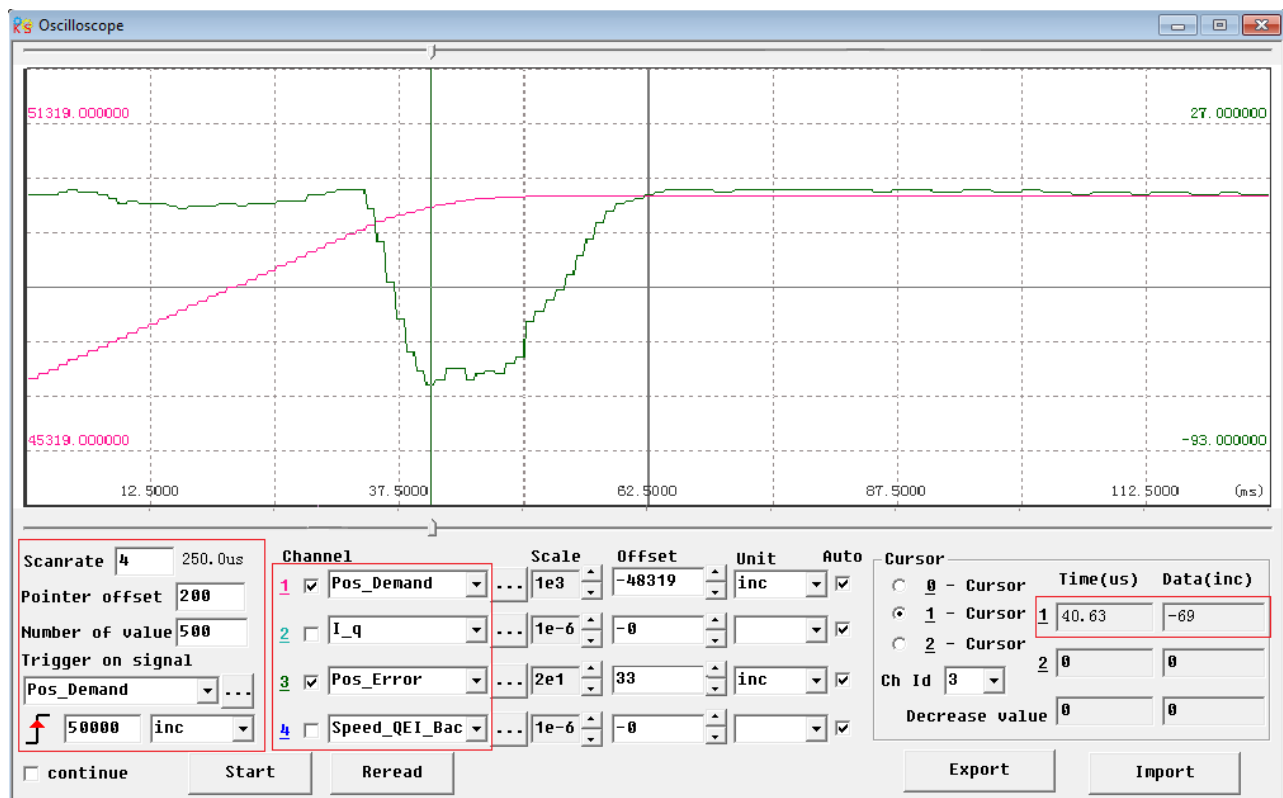
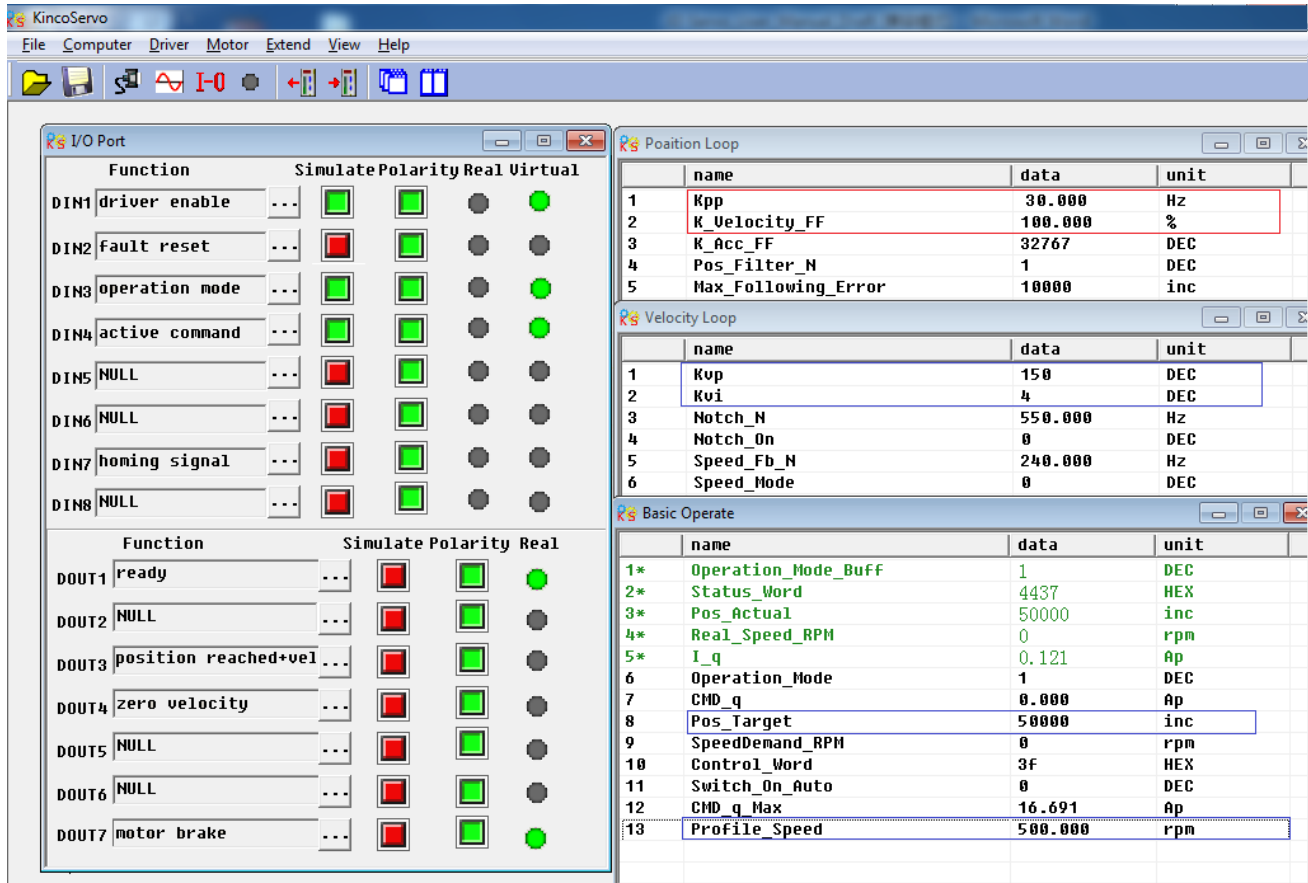


Fig.(2) Kpp=30,Vff=100%



The oscilloscope is as following: max. following error is 53 inc.

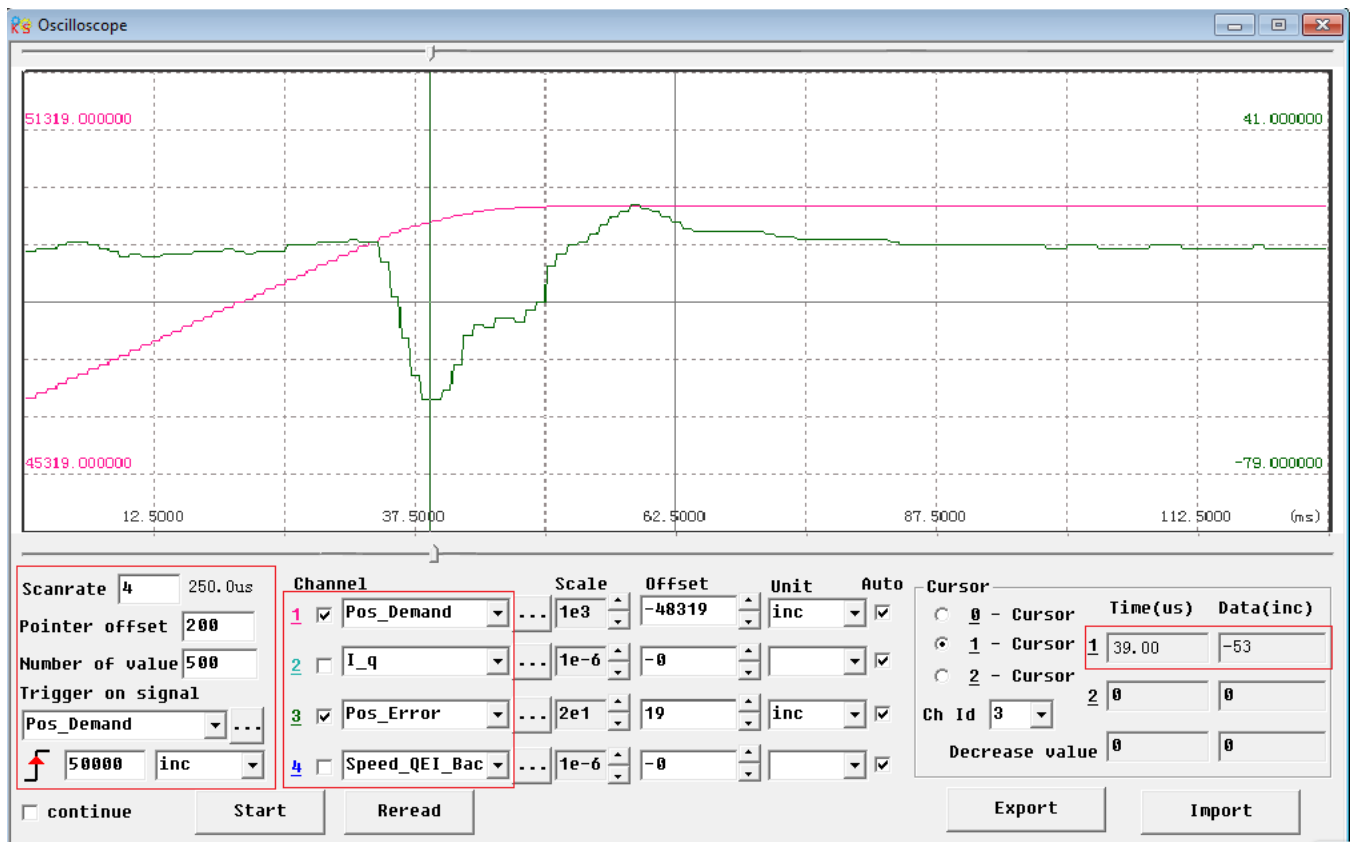
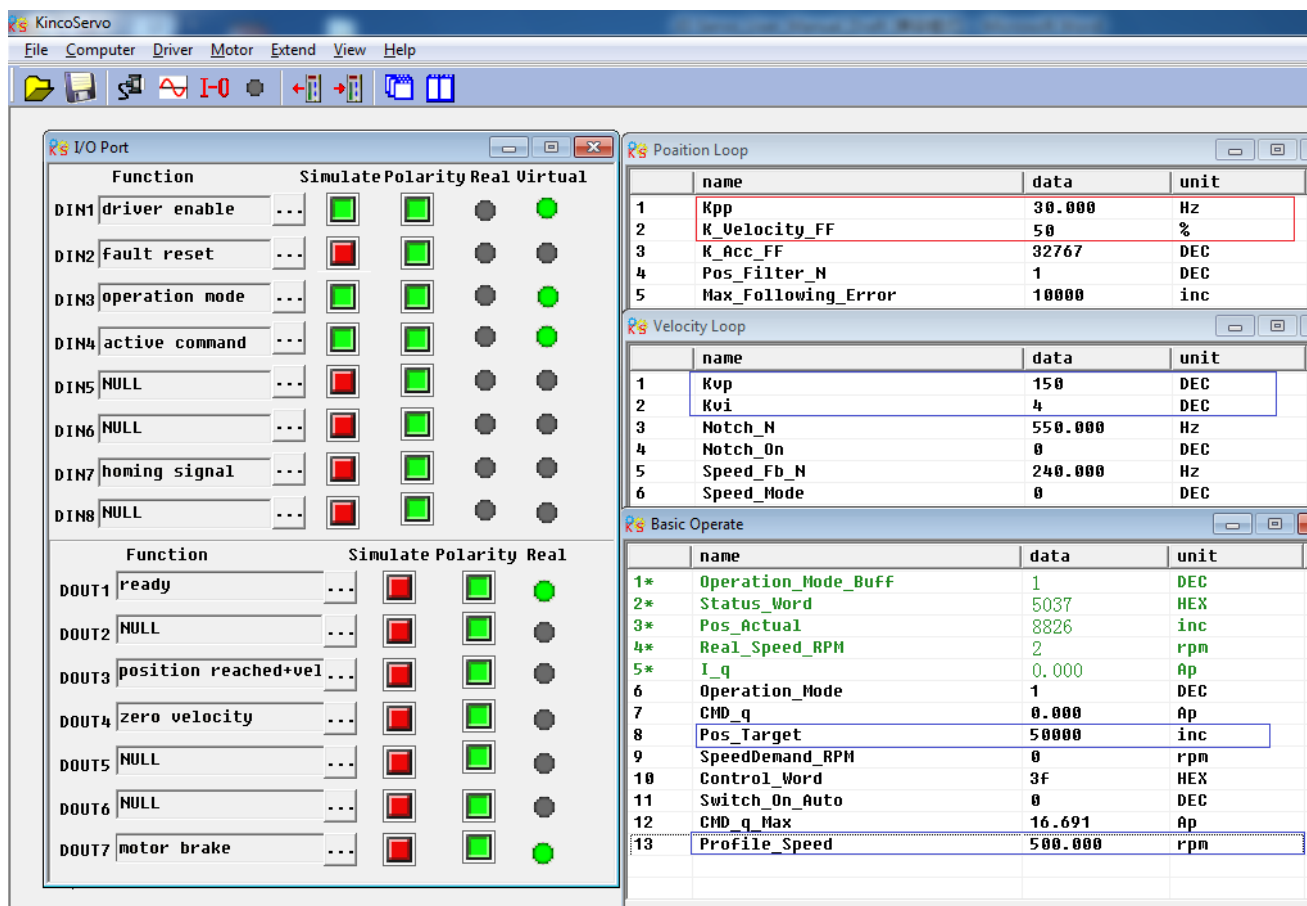
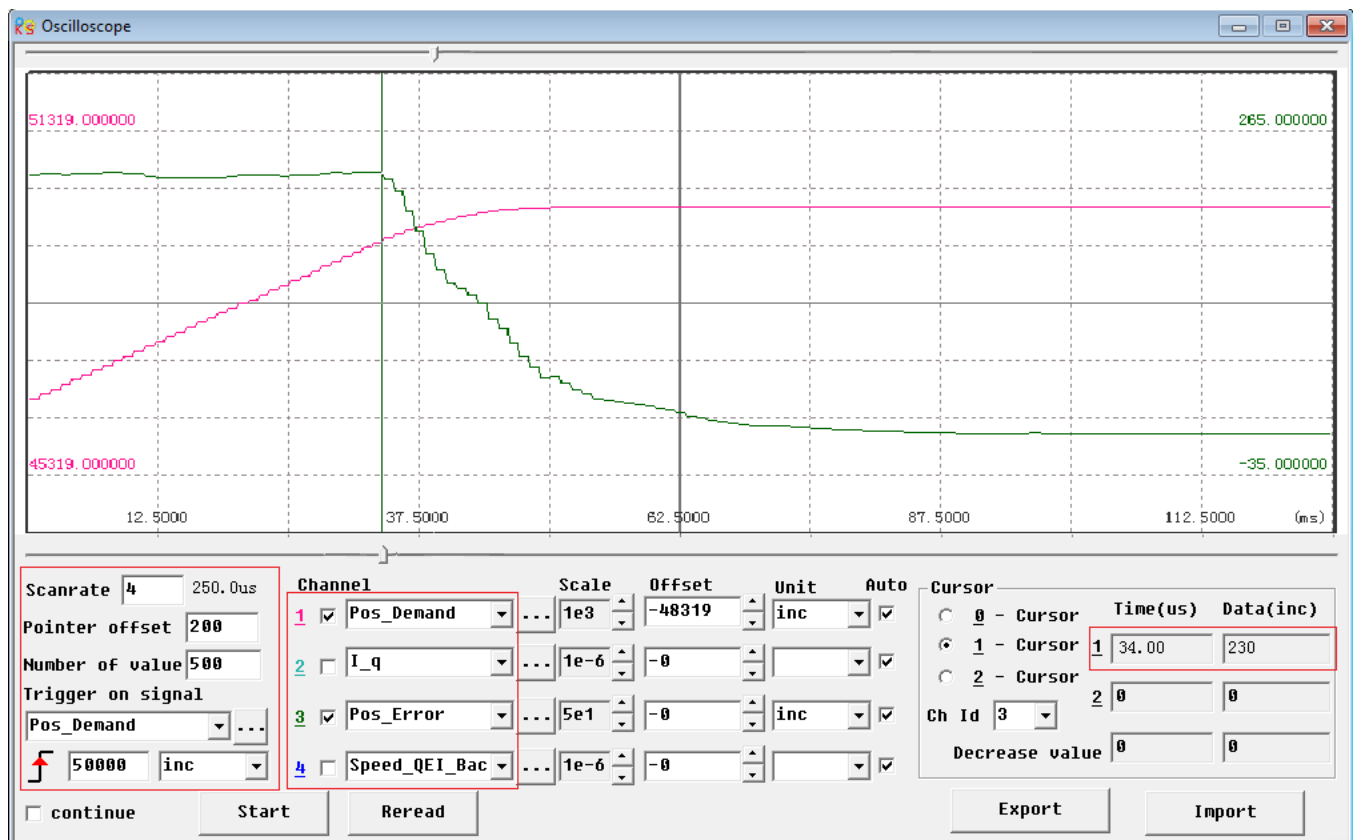


Fig.(3) Kpp=30,Vff=50%



The oscilloscope is as following: max. following error is 230 inc.



Chapter 7 Troubleshooting

7.1 Alarm Messages

Digital flickering on the display indicates that an alarm occurs indicating that the driver is faulty

The meanings of fault codes are as following table.

LED Display	Alarm Information
01	Internal
02	Encoder ABZ
03	Encoder UVW
04	Encoder Counting
05	Over Temperature
06	Over Voltage
07	Low Voltage
08	Over Current
09	Chop Resistor
10	Following Error
11	Logic Voltage <18V
12	Ilt Error
13	Over Frequency
14	Reserved
15	Commutation
16	EEPROM Error

When more than one alarms happen,the LED display will flicking the alarms alternately.

For example:if the encoder cable is not connected,then LED display will flicking between 02 and 03 alternately.

7.2 Troubleshooting

Alarm code	Alarm Information	Alarm Cause	Troubleshooting
000.1	Internal	Internal problem	Please contact manufacturer
000.2	Encoder ABZ	The ABZ signal cable is disconnected.	Check the cable.
000.4	Encoder UVW	The UVW signal cable is disconnected.	Check the cable.

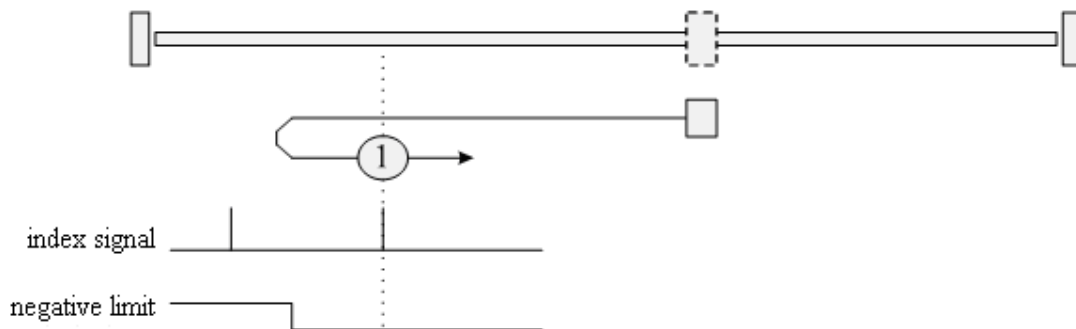
000.8	Encoder Counting	Interferences are suppressed. Encoder cable problem	Check encoder cable. Remove interference(Such as connect the motor cable to SHIELD terminal etc.)
000.6	Encoder Error	ABZ and UVW signals of the encoders incur error simultaneously.	Check the cable.
001.0	Over Temperature	The driver temperature exceeds 83°C.	Check whether the selected driver has enough power.
002.0	Over Voltage	The bus voltage of the driver exceeds the allowable range.	Check the input voltage,or determine whether a braking resistor is connected.
004.0	Low Voltage	The voltage of the driver bus is below the allowable range.	Check the input power. Power on AC first,then power DC. Reduce deceleration.
008.0	Over Current	The power tube in the driver is faulty, or short circuit occurs on the phase line of the motor.	Check motor wires. If the motor works properly, it can be judged that faults occur on the power tube in the driver.
010.0	Chop Resistor	The actual power of brake resistor is larger than rated power	Change brake resistor.
020.0	Following Error	Control loop parameters setting problem. Overload or block. Encoder signal problem.	Set VFF (d2.08) as 100%,increase kpp(d2.07) and kvp(d2.01). Choose bigger power motor or check whether the load is blocked. Check the encoder cable.
040.0	Logic Voltage	The logic voltage is lower than 18V.	Check the logic power supply 24V.
080.0	Ilt Error	Control loop parameters setting problem. Overload or block.	Increase kvp(d2.01). Choose bigger power motor or check whether the load is blocked.
100.0	Over Frequency	The input pulse frequency exceeds the allowable maximum value.	Check the input pulse frequency and the maximum permissible value of the frequency. (d3.38)。
200.0	STO Error	STO Error	Check the wiring according to Chapter 3.4.
400.0	Commutation	UVW signal of encoder cable problem	Check encoder cable.
800.0	EEPROM Error	Because of updating firmware. Driver internal problem.	Initialize all control parameters and save,then restart driver. Contact manufacturer.

Chapter 8 Appendix

8.1 Homing Mode

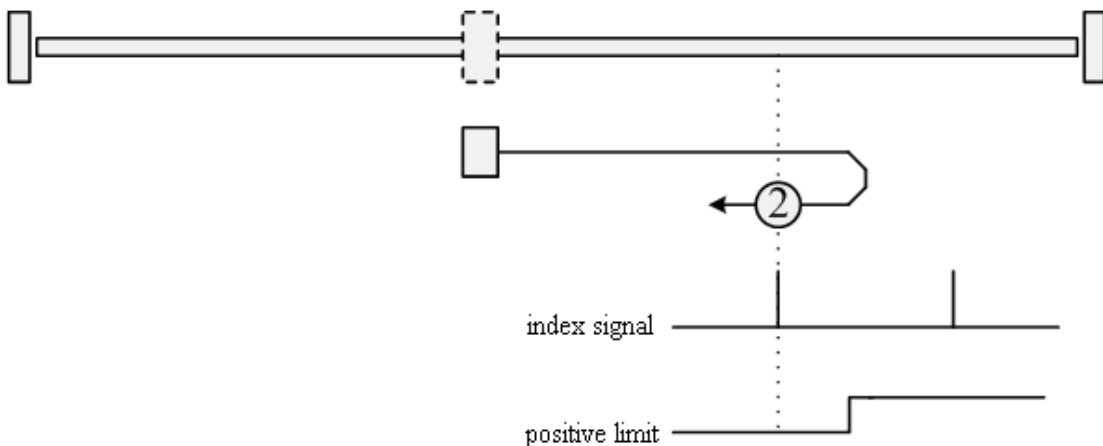
Method 1: Homing on the negative limit switch and index pulse

Using this method, the initial direction of movement is leftward if the negative limit switch is inactive (here shown as low). The home position is at the first index pulse to the right of the position where the negative limit switch becomes inactive.



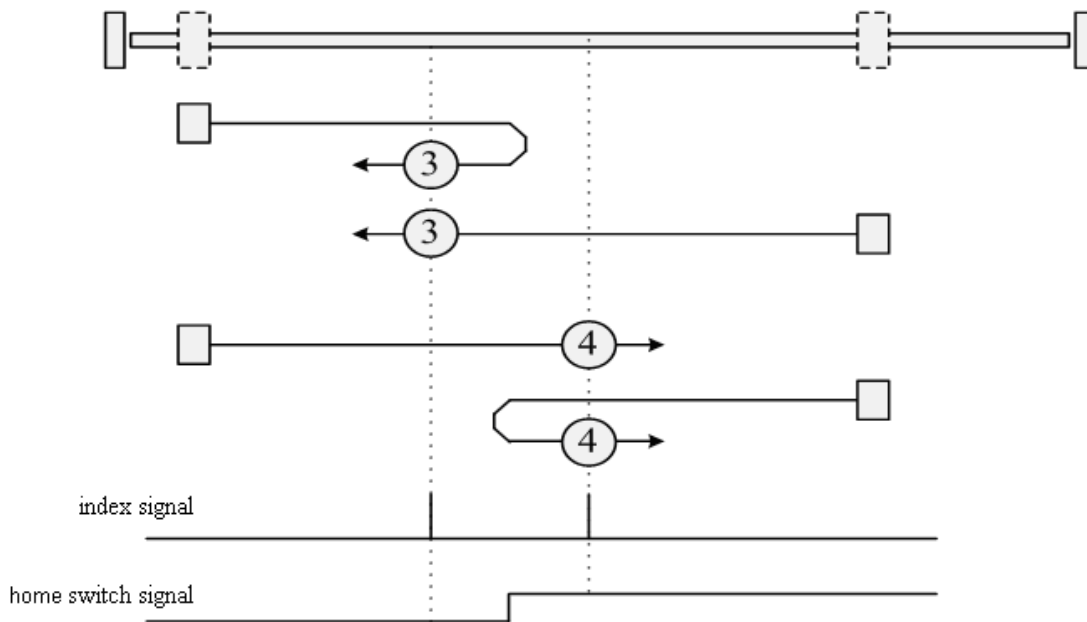
Method 2: Homing on the positive limit switch and index pulse

Using this method, the initial direction of movement is rightward if the positive limit switch is inactive (here shown as low). The position of home is at the first index pulse to the left of the position where the positive limit switch becomes inactive.



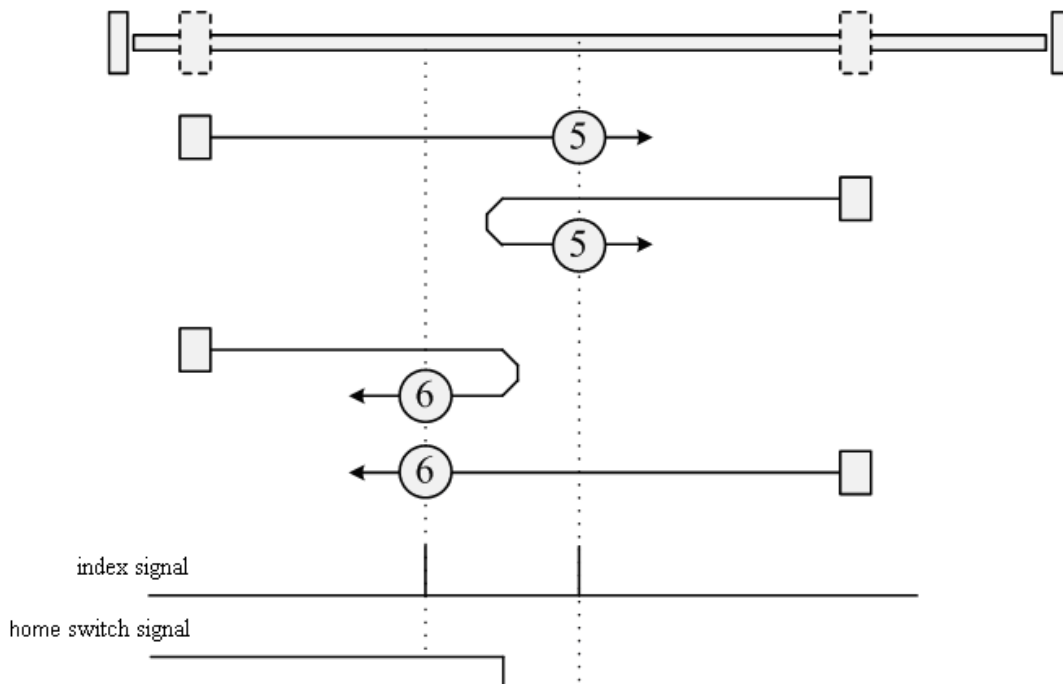
Methods 3 and 4: Homing on the positive home switch and index pulse

Using methods 3 or 4, the initial direction of movement is dependent on the state of the home switch. The home position is at the index pulse to either the left or right of the point where the home switch changes state. If the initial position is sited so that the direction of movement must reverse during homing, the point at which the reversal takes place is anywhere after a change of state of the home switch.



Methods 5 and 6: Homing on the negative home switch and index pulse

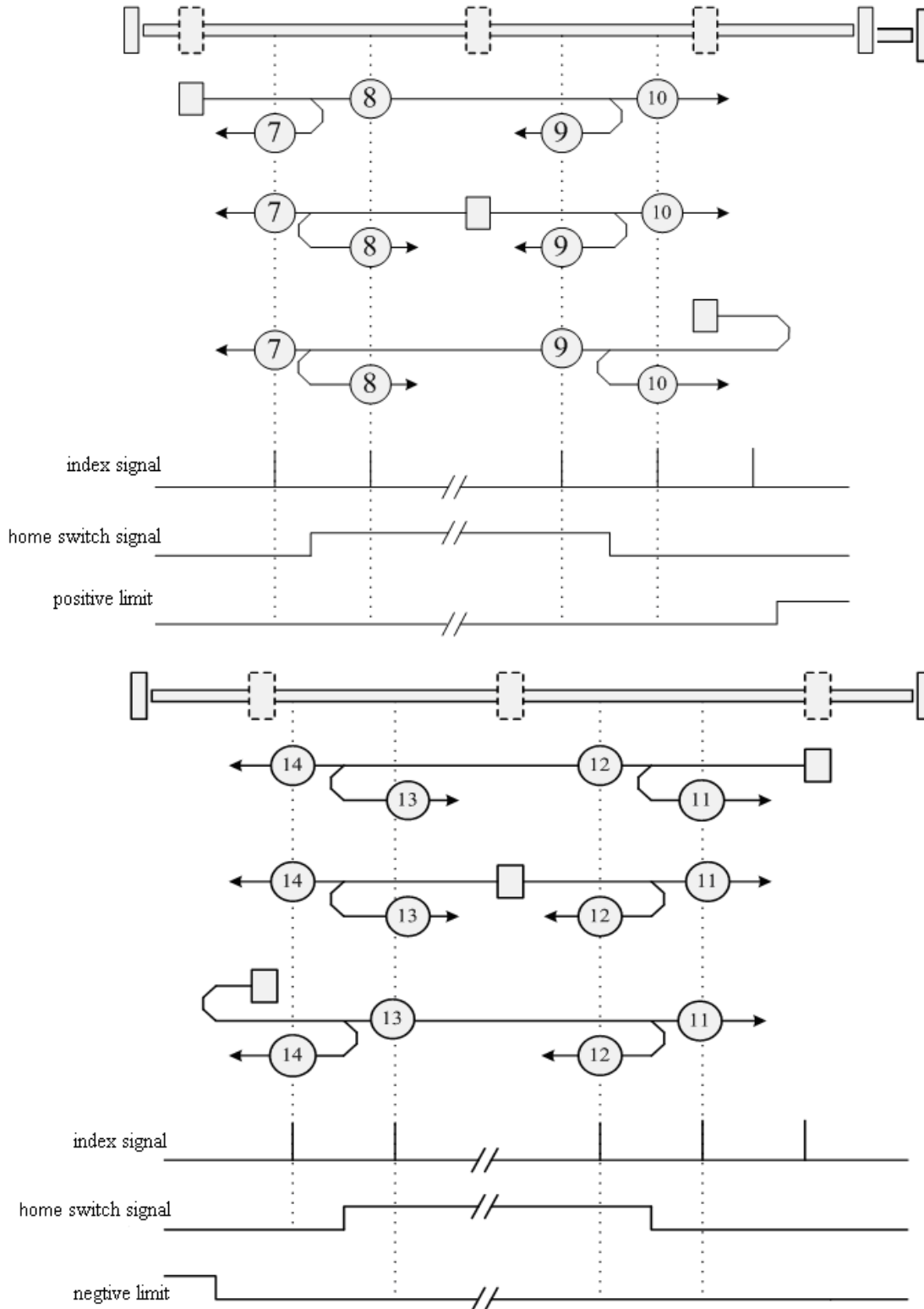
Using methods 5 or 6, the initial direction of movement is dependent on the state of the home switch. The home position is at the index pulse to either the left or the right of the point where the home switch changes state. If the initial position is sited so that the direction of movement must reverse during homing, the point at which the reversal takes place is anywhere after a change of state of the home switch.



Methods 7 to 14: Homing on the home switch and index pulse

These methods use a home switch that is active over only a portion of the travel; in effect the switch has a “momentary” action as the axle position sweeps past the switch. Using methods 7 to 10, the initial direction of movement is to the right, and using methods 11 to 14, the initial direction of movement is to the left, except if the home switch is active at the start of motion. In this case, the initial direction of motion is dependent on the edge being sought. The home position is at the index pulse on either side of the rising or falling edges of the home switch, as shown in the following two diagrams. If the initial direction of movement leads away from the home switch, the drive must reverse on encountering the relevant limit

switch.

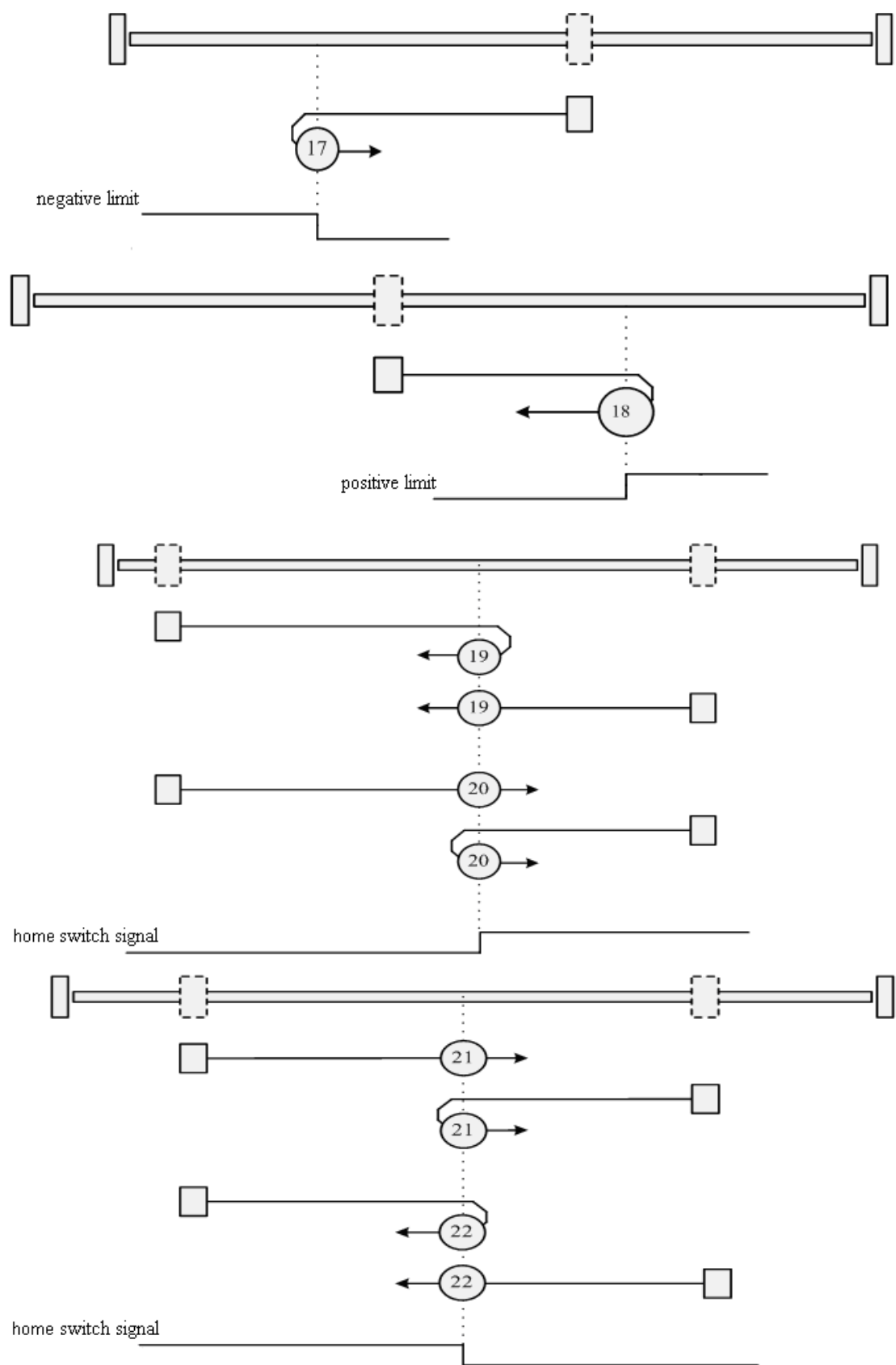


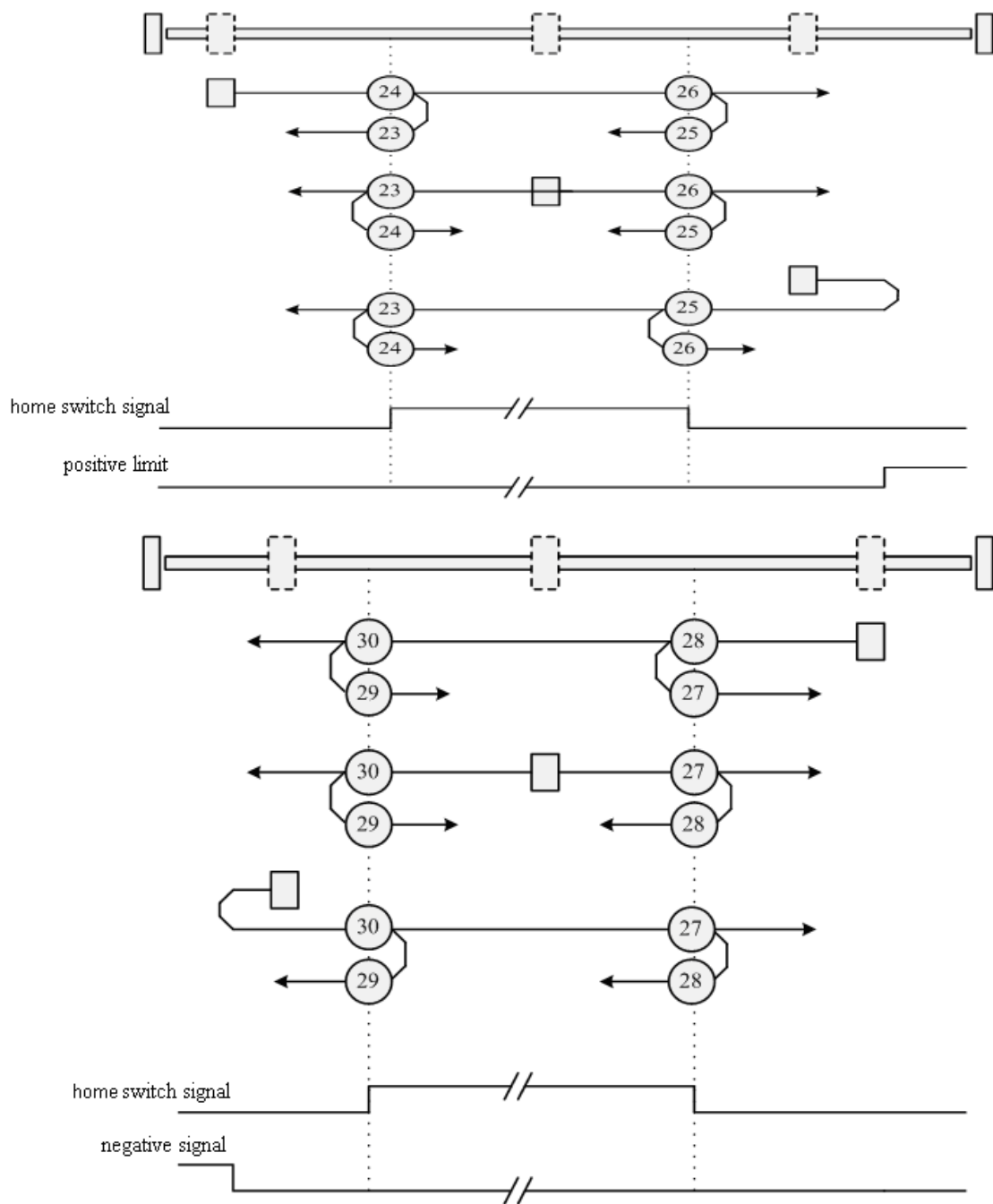
Methods 15 and 16: Reserved

These methods are reserved for future expansion of the homing mode.

Methods 17 to 30: Homing without an index pulse

These methods are similar to methods 1 to 14, except that the home position is not dependent on the index pulse; it is dependent only on the relevant home or limit switch transitions. For example, methods 19 and 20 are similar to methods 3 and 4, as shown in the following diagram:

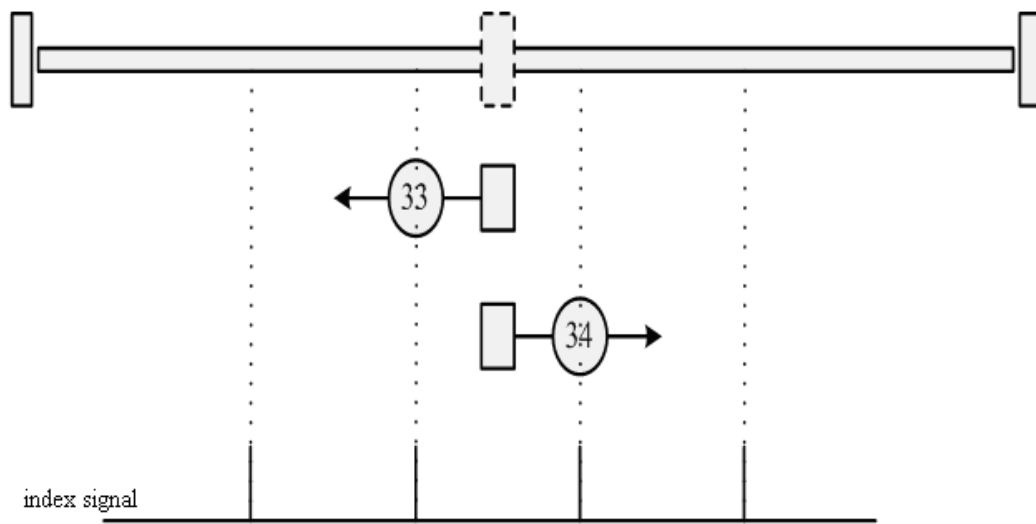




Methods 31 and 32: Reserved

These methods are reserved for future expansion of the homing mode.

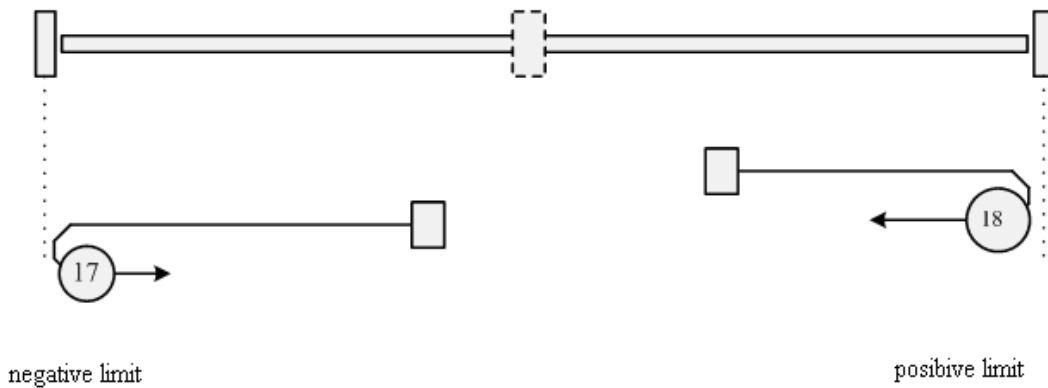
Methods 33 and 34: Homing on the index



Method 35: Homing on the current position

In this method, the current position is taken to be the home position.

Methods -17 and -18: Use the mechanical terminal as reference point



8.2 Servo Drivers and Motors Selection Table

Series	Servo Driver	Servo Motor	Description	Power Cable	Encoder Cable	Rated speed/ Rated torque/ Rated current
Small inertia DC60V	CD120-AA-000	57S-0008-08AAK-FDFH	Standard direct cable motor	MOT-005-LL-KL-D	ENCCF-LL-FH	800rpm/ 1Nm/ 5.6A
		57S-0015-08AAK-FDFH				800rpm/ 1.5Nm/ 5.8A
		SME60S-0020-30AAK-3DKH				3000rpm/ 0.64Nm/ 4.8A

8.3 Technical Specifications of Servo Driver

Model Parameters		CD120-AA-000
Power supply	Main power	Power Supply: 18~70V DC (60V DC recommended)
	Logic power	DC24V 1A
Current	Peak current(PEAK)	18A
Feedback signal		2500PPR(Incremental 5V difference encoder)
Brake chopper		Use an external brake resistor if necessary in the high speed start and stop application
Brake chopper threshold		DC80V±5V
Over-voltage alarming threshold		DC90V±5V
Under-voltage alarming threshold		DC18V±5V
Coolin method		Natural air cooling
Weight		0.9kg
Position Mode	Max.frequency of input pluse	Differential signal:500KPPS,Open-collector signal:200KPPS
	Pluse command mode	Pluse+direction,CCW+CW,(5V,If signal is 24V, 2K resistor is needed. Do not support A+B phase signal)
	Command smoothing	Low-pass filtering(Adjustable by internal parameter setting)
	Feedforward gain	Adjustable by internal parameter setting
	Gear ratio	Setting range Gear factor:-32768~32767,Gear divider:1~32767 1/50≤1Gear factor/Gear divider1≤50
	Position loop sampling frequency	1KHz
Speed Mode	Analog input voltage range	0~±10V(Resolution 12 bit)
	Input impedance	200K
	Analog input sampling frequency	4KHz
	Command source	External analog command/internal command
	Command smoothing	Low-pass filtering(Adjustable by internal parameter setting)
	Input voltage dead-zone setting	Adjustable by internal parameter setting
	Input voltage offset setting	Adjustable by internal parameter setting
	Speed limit	Adjustable by internal parameter setting
	Torque limit	Internal parameters setting/external analog command control
	Speed sampling frequency	4KHz
Torque Mode	Analog voltage input range	0~±10V(Resolution 12 bit)
	Input impedance	200K
	Input sampling frequency	4KHz
	Command source	External analog command/internal command
	Command smoothing	Low-pass filtering(Adjustable by internal parameter setting)
	Speed limit	Internal parameters setting/external analog command control
	Input voltage dead-zone setting	Adjustable by internal parameter setting
	Input voltage offset setting	Adjustable by internal parameter setting
	Current sampling frequency	16KHz
Digital Input	Input specification	4 digital input, high level(effective if voltage is above 12V)
	Input function	Define the following functions freely: driver enable, driver fault reset, driver mode control , speed loop Kp control, positive limit, negative limit,home signal, emergency stop and so on
Digital Output	Output specification	3 digital output, OUT1 and OUT2 is 100mA, OUT5 is 800mA, can drive brake device directly
	Output function	Define the following functions freely: driver ready, driver fault, position reached, motor at zero speed, speed reached, index signal Z appears, home found and so on.
Protection function		Over-voltage protection, under-voltage protection, motor over-heat, short-circuit protection and so on
Communication port		RS232
Operation Environment	Operation temperature	0~40℃
	Storage temperature	-10℃~70℃
	Humidity(non-condensing)	5~95%
	Protection class	IP20
	Installation environment	Dust-free, dry and lockable environment (such as in a electrical cabinet)
	Installation method	Vertical installation
	Altitude	Below 1000m
	Atmospheric pressure	86kpa~106kpa

8.4 Technical Specifications of Servo Motor

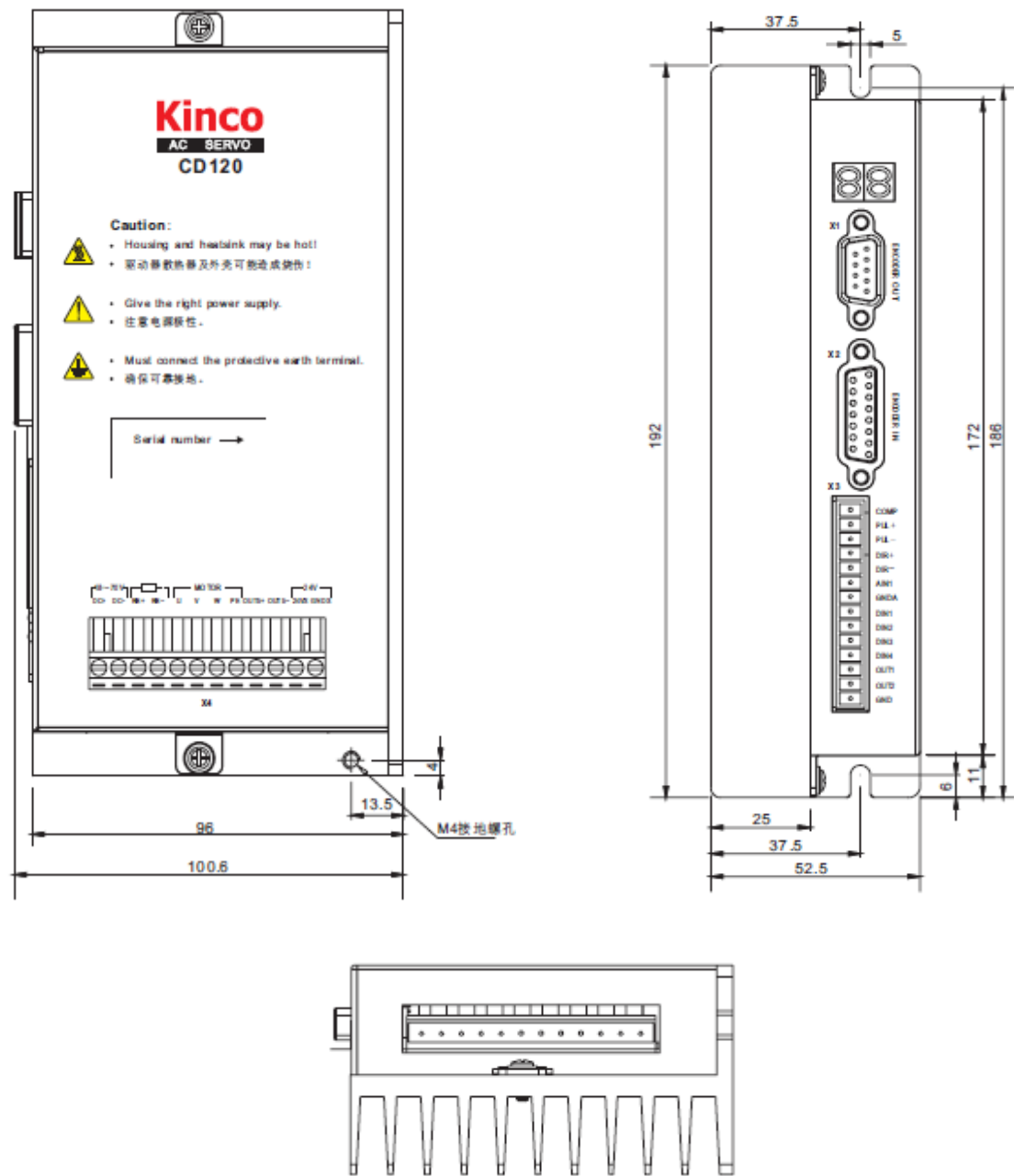
8.4.1 SME Series

Motor Series		Small Inertia Flange Size: 60mm
Motor model		SME60S-0020-30AAK-3DKH
Compatible driver		CD120-AA-000
DC link voltage UDC		60
Continuous performance	Rated power P _n (W)	200
	Rated torque T _n (Nm)	0.64
	Rated speed N _m (rpm)	3000
	Rated current I _n (A)	4.8
Max. torque T _m (Nm)		1.92
Max. current I _m (A)		13.8
Standstill torque T _s (Nm)		0.7
Standstill current I _s (A)		5.06
Resistance(line-line) R _L (Ω)		0.7
Inductance(line-line) L _L (mH)		1.55
Electrical time constant τ _e (ms)		2.21
Mechanical time constant τ _m (ms)		2.05
Reverse voltage constant K _e (V/krpm)		9
Torque constant K _t (Nm/A)		0.149
Total moment of inertia J _m (Kg·cm ²)		0.375
Pole pair		3
Maximum voltage rising du/dt (KV/μs)		8
Insulation class		F
Radial force F(N)		180
Axial force F(N)		90
Weight G(Kg)		1.3
Length of motor L(mm)		120 ± 1.5
Position feedback device		2500ppr photoelectric encoder(incremental)
Cooling method		Wholly enclosed, self cooling
Protection class		IP54 at shaft side
Operation environment	Temperature	-20 ~ 40℃
	Humidity	Below 90RH(non-condensing)
	Ambient environment	Away from corrosive /combustible gas. oil drops and dust
	Altitude	Max, altitude 4000m, Rated power at 1000m or below(Power decreases 1.5% per 100m when altitude rise)

8.4.2 F Series

F Series Motor	Small Inertia Flange Size:57mm	
Motor model	57S-0008-08AAK-FDFH	57S-0015-08AAK-FDFH
Compatible driver	CD120-AA-000	CD120-AA-000
Phase current (A)	5.6	5.8
Rated torque (Nm)	1	1.5
Damping torque (Nm)	0.04	0.068
Phase resistance (Ω)	0.47	0.7
Phase inductance (mH)	1.7	2.4
Motor inertia (Kg.cm ²)	0.3	0.48
Length of motor L(mm)	90 ± 1.5	113 ± 1.5
Lead number	4	4
Insulation class	B	B
Withstand voltage class	600V AC 1S 5mA	600V AC 1S 5mA
Radial force (N)	15	15
Axial force (N)	75	75
Operation temperature	-20 ~ 50℃	-20 ~ 50℃
Surface temperature	Maximum 80℃	Maximum 80℃
Insulation impedance	Minimum 100M Ω , 500V DC	Minimum 100M Ω , 500V DC
Weight (Kg)	1.05	1.3

8.5 Dimensions of Servo Driver (Unit: mm)



8.6 Brake Resistor Selection Table

Servo Driver	Servo Motor	Brake Resistor
CD120-AA-000	57S-0008-08AAK-FDFH	39Ω
	57S-0015-08AAK-FDFH	39Ω
	SME60S-0020-30AAK-3DKH	39Ω